THE SOUND TRACK

BOOK of the THEATRE

THE SOUND TRACK BOOK OF THE THEATRE

A Selection of the Best Articles from THE SOUND TRACK on

Projection and Sound

Theatre Management and Maintenance

Recent Theatre Developments

THE SOUND TRACK

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INTRODUCTION

The Sound Track was launched in the midst of World War II as the answer to a problem which had arisen at that time.

With the outbreak of the War, virtually all equipment manufacturers devoted their entire production to turning out the tools of war. Those theatres with equipment which was outmoded and on the point of replacement found themselves faced with the necessity of struggling along with what they had over the next several years.

To make a bad situation worse, the armed forces had called many of the experienced projectionists and theatre managers of the country, so that it was necessary to fill their places with untrained and hastily recruited men and women. This combination of equipment on the point of collapse and of untrained projectionists in the booth threatened to bring about the closing of many theatres.

The Motiograph theatre equipment dealers and the Motiograph Company decided that they could make a worthwhile contribution to the motion picture theatre industry by bringing as much help as possible to the theatre owners when they needed it. As a result, The Sound Track was launched in May of 1943.

The Sound Track had nothing to sell, because there was no equipment being manufactured, and it seemed a long time before there would be. It devoted itself to bringing information on how to keep old equipment in operating condition, and of providing instruction on the essentials of motion picture projection and management to those who were breaking into theatre business, as well as to the older men who were sufficiently alert to realize that there was always something to learn.

The magazine was mailed to the vast majority of the theatres of the United States and Canada without charge, as all of the costs have been defrayed by the Motiograph dealers and by Motiograph.

During the ensuing years, The Sound Track published articles on almost every type of booth equipment, outlining its construction, operation and

maintenance, as well as on such subjects as theatre supplies and fixtures, theatre management, the principal motion picture producers, and the latest developments in the industry. A policy was followed of treating each subject fully and accurately, and yet in clear and understandable language. Every issue contained a large number of quality illustrations, and was printed in color upon a good paper stock and in modern and attractive format.

Among its accomplishments, The Sound Track established and conducted the Used Equipment Mart, a non-profit service to theatre owners and equipment dealers, which moved in excess of $300,000 of used theatre equipment, and thus prevented the closing of many a theatre. It likewise operated the Wartime Emergency Replacement Service, which moved projection room equipment and replacement parts between equipment dealers in all parts of the country in order to meet emergency situations as they arose.

The Sound Track has received as many as one thousand letters in the course of a month, and over four thousand testimonials from readers in the course of its existence. During the first year of publication alone there were over six hundred individual answers returned to inquiries on projection problems.

The resumption of normal production following the war marked the fulfillment of the original objectives of The Sound Track, but by that time there was a spontaneous demand for its continuance. It has consequently continued to bring information on the postwar equipment and the latest developments in the theatre world.

Many of the letters mentioned above constituted requests for back numbers of the publication. While a considerable quantity of additional copies were printed of each issue, this supply was invariably exhausted within a short time. The inability to comply with these requests was particularly unfortunate in many cases, such as those of projectionists who were saving issues and building up a library, or of inexperienced men and women who seemed to be in need of further instruction.

The present volume was therefore prepared as the response to these requests. It constitutes a reprint of all of the most important articles which have appeared in The Sound Track since its beginning, revised when necessary to bring the information up to date, and supplemented with the original illustrations. It is our hope that it satisfactorily fulfills its purpose of furnishing an encyclopedia of trustworthy theatre information to the theatre owner, the manager and the projectionist.

It is, of course, impossible to describe all brands of all types of theatre equipment and supplies—a difficulty which other publications of this type have recognized by confining themselves to one or a very few of the leading brands. Direct reference is made in this book only to those brands of equipment and supplies handled by the Motiograph dealers, who, it will be recalled, helped to make possible the publication of the magazine. The models described incorporate basic principles of design, so that a knowledge of their construction and operation will be found applicable in nearly all cases. It will be found, moreover, that an explanation is given in nearly every case in which one of the leading brands differs from that being described, so that there is probably little essential information which has been omitted. In no case is there either direct or implied disparagement of any product.

In conclusion, it is only fitting and proper that due acknowledgment of thanks be made to the officers and executives of Motiograph, to the many valued contributors of articles to The Sound Track, and to the following Motiograph theatre equipment dealers:

Atlas Theatre Supply Co.	Pittsburgh, Pa.
Joe Cifre, Inc.	Boston, Mass.
Des Moines Theatre Supply	Des Moines, Iowa
J. F. Dusman Co.	Baltimore, Md.
Ger-Bar, Inc.	Indianapolis, Ind.
Hodges Theatre Supply Co.	New Orleans, La.
Joe Hornstein, Inc.	New York, N. Y.
W. R. Howell	Oklahoma City, Okla.
Mid-States Theatre Supply	St. Louis, Mo.
Modern Theatre Equipment	Dallas, Texas
Ohio Theatre Supply Co.	Cleveland, Ohio
Ringold Theatre Equipment	Grand Rapids, Mich.
Service Theatre Supply	Salt Lake City, Utah
B. F. Shearer Company	Los Angeles, Calif.
B. F. Shearer Company	Portland, Ore
B. F. Shearer Company	San Francisco, Calif.
B. F. Shearer Company	Seattle, Wash.
Shreve Theatre Supply	Kansas City, Mo.
The Ray Smith Company	Milwaukee, Wis.
Vincent M. Tate	Forty Fort, Pa.
Theatre Supply Co.	Fort Smith, Ark.
Wil-Kin Theatre Supply, Inc.	Atlanta, Ga.
Wil-Kin Theatre Supply, Inc.	Charlotte, No. Caro.
Dominion Sound Equipments, Ltd.	(Branches throughout Canada)

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PART ONE

PROJECTION AND SOUND

A Model Projection Room

An Aid to Planning Your Better Booth

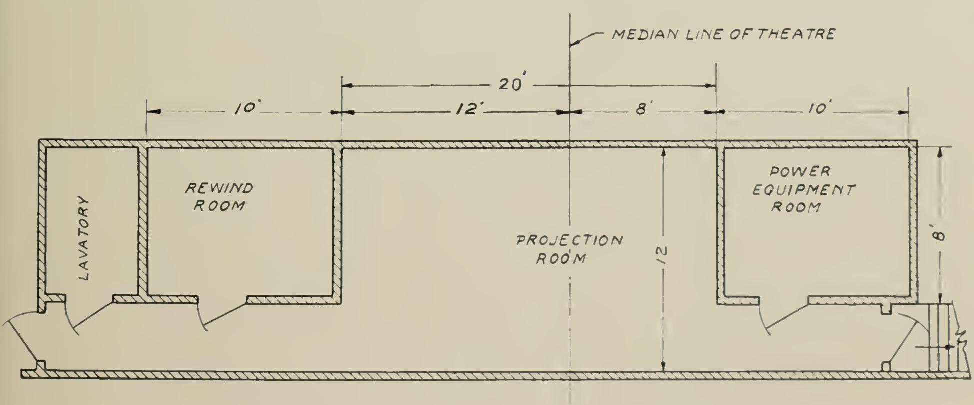
By EMIL J. WIENKE

Just what constitutes a model projection room? Perhaps the word "model" embraces too ambitious a term, for we are still many years away from perfection—if such a goal may ever be attained. What we are trying to outline here is simply the result of experience gained over two score or more years of motion picture projection for the purpose of achieving the greatest possible degree of projection efficiency.

There is no doubt but that we have better projection rooms now than we have had in the past. True enough, there are still plenty of "rat-holes" that are just as dangerous as they are unsanitary, but their number is fast diminishing. On the other hand, we can point with real pride to many more projection rooms that constitute a credit to the industry and to the owners and projectionists who maintain them.

Inasmuch as the sole purpose of a motion picture theatre is the presentation of motion pictures, it is obvious that the success or failure of any such business will revolve about the quality of the projection and sound. The first essential, of course, is to have good equipment. In order to obtain the greatest possible value from such equipment, it should be installed in a projection booth which measures up as closely as possible to the ideal requirements which have been determined from experience.

Dollars invested in the projection booth pay greater returns than in any other part



Floor plan of a model projection room.

of the theatre. The projectionist who is given good equipment and suitable working quarters will unquestionably display far greater care and interest in his work.

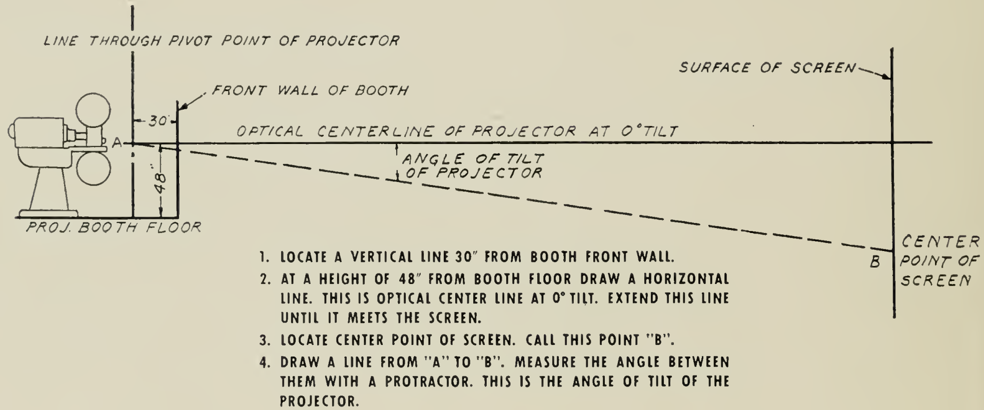
The Projection Room

The ideal projection booth consists of four divisions—the projection room, the rewind room, the power equipment room and the lavatory.

In discussing the projection room itself—by far the most important portion of the

The reader will note our emphasis on the figures given as minimum dimensions. In planning a projection room, consideration should be given to probable future needs for additional space. The theatre architect and the theatre equipment dealer may be counted on to give qualified advice on this subject, and should be consulted without fail.

In planning the projection room, consideration must be given to its relation to the screen and to the vertical projection angle.



Method for plotting projection angle on elevation drawing.

booth—we may assume that the average theatre is equipped with two projectors and a spotlight or effect machine. Competent engineering authorities in the field have agreed upon specifications which call for a minimum width of eight feet of space for the first projector, and of six feet for each additional projector or effect machine. This gives us a total minimum width of twenty feet for the average theatre projection room. If a third projector is desired, another six feet of space would of course be required, making a total of 26 feet.

While a depth of ten feet is sufficient for the requirements of the projection room itself, a depth of twelve feet or more is recommended in order to provide for exit space at both ends of the booth. The height of the room should be at least eight feet.

Inasmuch as the ideal projection angle is one of zero degrees, every effort should be made to approach this ideal as closely as possible, and in no case should the vertical projection angle exceed 14 degrees. The optical axes of the projectors should be five feet apart, and when two projectors are used, they are to be equidistant from the median line of the theatre. If there are three projectors, the optical axis of one shall be placed on the median line, and the other two projectors spaced at an equal distance on either side. Motion picture projectors should in all cases be given preference in spacing in relation to the median line over spotlight or effect machines.

Even when state or municipal fire laws do not so make it mandatory, it is good

policy to provide a separate room for storage and rewinding of film. A room about eight feet in depth by ten feet in width will usually prove sufficient for this purpose.

It is equally advisable to have a power equipment room for the housing of rheostats, generators and rectifiers. While the size of this room will be determined by the quantity and type of equipment, the dimensions given above for a rewind room are generally applicable here as well.

Construction of Booth

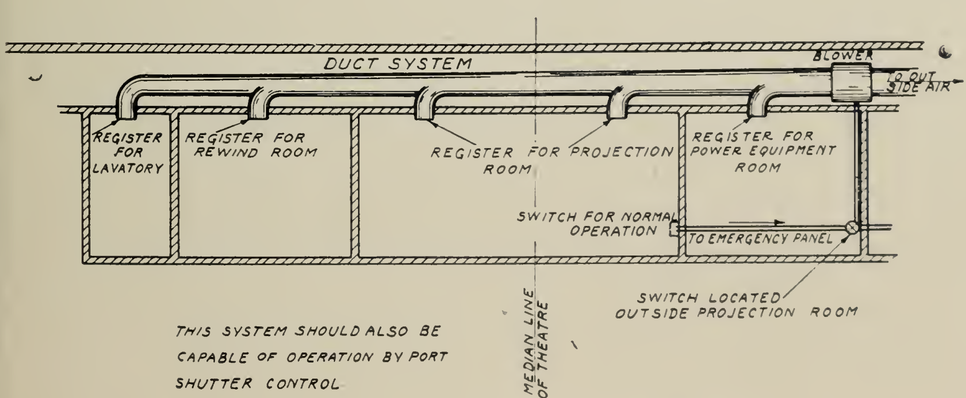
The prime point to be considered in the construction of the booth is the question of fireproofing. The specifications given below are in accordance with virtually all state and municipal fire-proof regulations.

The core of the projection room walls should be not less than four inches thick, and constructed of concrete, or of brick or tile blocks plastered on the inside with ¾ inch cement or acoustical plaster. If plaster block is employed, it should be supported upon steel framework. Provision should be made in wall construction for masonry chases for all electrical conduits.

Good ceiling construction materials include four inch concrete slabs or pre-cast concrete, or three inch plaster blocks supported by a steel structure and plastered on the inside in the same manner as the walls. Electrical conduits in the ceiling should be concealed. The ceiling and the upper half of the walls should be covered with an approved fireproof acoustical material both for preventing the transmission of noise into the auditorium and reducing noise within the projection room itself.

The principal point to be remembered in regard to the floor of the projection booth is that it must be constructed to bear a heavy load, for the equipment weighs in the neighborhood of three thousand pounds. Qualified engineers recommend a minimum strength of two hundred pounds per square foot, and it will be well to allow a generous factor of safety. A preferred type of floor construction consists of a reinforced concrete slab at least four inches thick, covered with from two to four inches of tamped cinders and with a finished cement floor not less than two inches thick. The cinder filling and the cement floor will provide space for concealed electric conduits. Where fire regulations so permit, the floor should be covered with linoleum, which tends to improve the appearance and lessens the accumulation of dust and grit.

Every projection room should be provided with an exit at each end. The exit doors, as well as those into the rewind and power equipment rooms, must be approved fire-doors, and of a minimum size of two



General and emergency ventilation system for booth.

feet six inches wide by six feet eight inches high. All doors should close automatically, and swing outwardly, so that they may be opened from the inside merely by pushing. Door jambs should be made of steel.

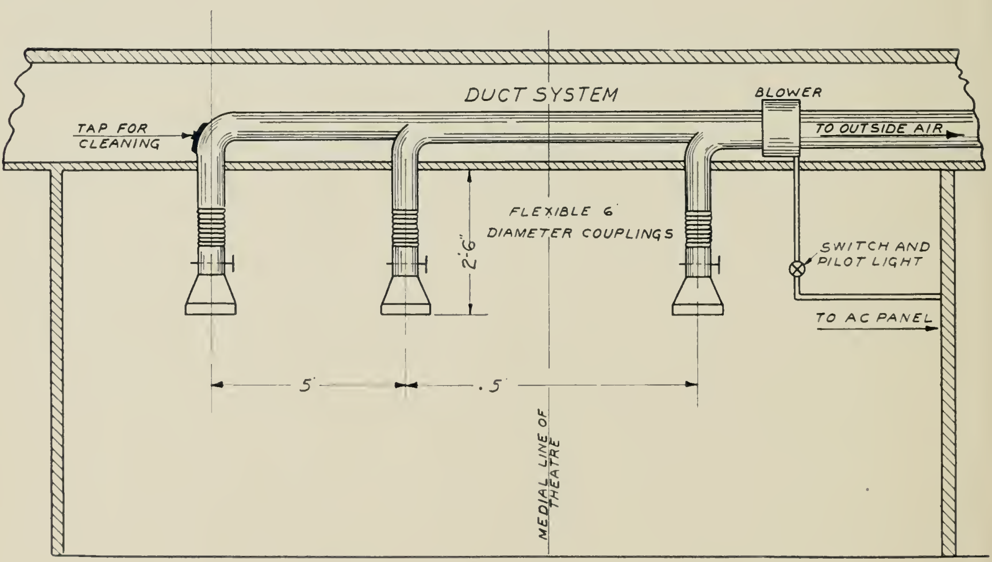
We have already mentioned the necessity of an exit at each end of the projection booth. These exits must be direct and unobstructed, with a space of at least three feet between the walls. As the exit doors should open outward, there must be a platform at the head of the stairs at least equal to the width of the door. The stairs themselves should have a tread of nine inches or more, and with risers not in excess of eight inches. Devious winding stairs are to be avoided, while it is hoped that the old fashioned fire trap booths which had ladders and trap doors as the sole means of entrance are definitely extinct by this time.

While there are few theatres in which the projection room is built against the exterior wall, one or more outside windows may be provided when this is the case. Any such windows must be entirely of steel construction, with glass of the shatterproof type. While outside windows have certain advantages, they are not to be recommended because of the dirt and dust which enters the projection room from the outdoors.

Equipping the Projection Booth

Now that the projection room has been intelligently and safely constructed, it must be finished and equipped in the same manner to give a maximum degree of efficiency.

Some thought should be given to the appearance of the projection room. We have already suggested covering the floor with battleship linoleum cemented to the floor, when fire regulations so permit. A frequent application of paint to the projection room walls will greatly enhance the appearance and provide an incentive to cleanliness. The colors of the paint to be



EQUIPMENT VENTILATION SYSTEM BLOWER CAPACITY 400 CU. FT. PER MIN
MINIMUM AIR MOVEMENT THROUGH LAMP HOUSES WITH BLOWER IDLE, 15 CU. FT PER MINUTE
2'6" DIMENSION IS FOR ZERO DEGREES TILT OF PROJECTOR

Ventilation system for booth equipment.

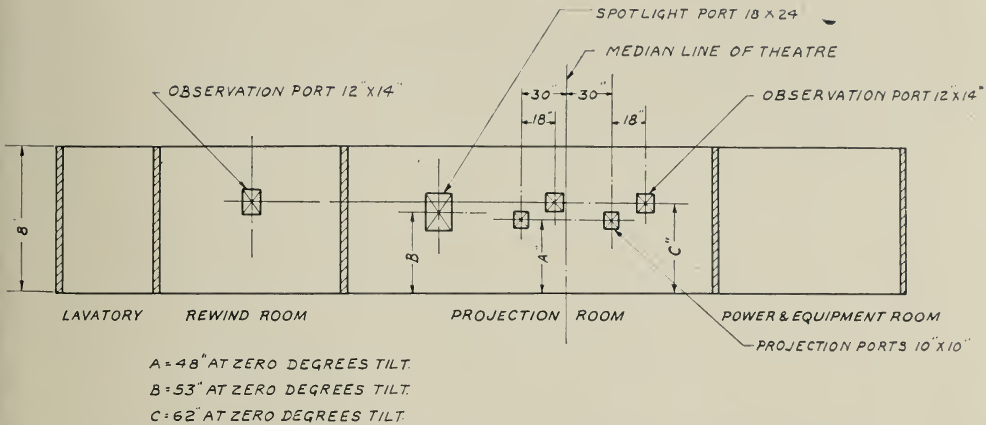


Diagram of front wall of projection room, showing locations of portholes.

employed are a matter of individual taste, although common sense would suggest that the lower walls below the acoustical covering be in a dark color, while the upper walls and ceiling should be in a lighter shade.

Projection room lighting may be provided by approved vapor-proof ceiling fixtures arranged from either the normal or the emergency lighting circuit. Individual vapor-proof ceiling fixtures should be installed at the operating side of each projector or effect machine, with a single vapor-proof reel-light, covered with a wire guard, centrally located on the projection room ceiling and equipped with sufficient cord to permit extension to all parts of the room. All projection room lighting fixtures should be equipped with keyless sockets and controlled from wall sockets.

Proper ventilation of the projection room is of the utmost importance, and comprises three types of facilities—a projection room exhaust system, a ventilation system for the arc lamps, and a fresh air supply to the booth.

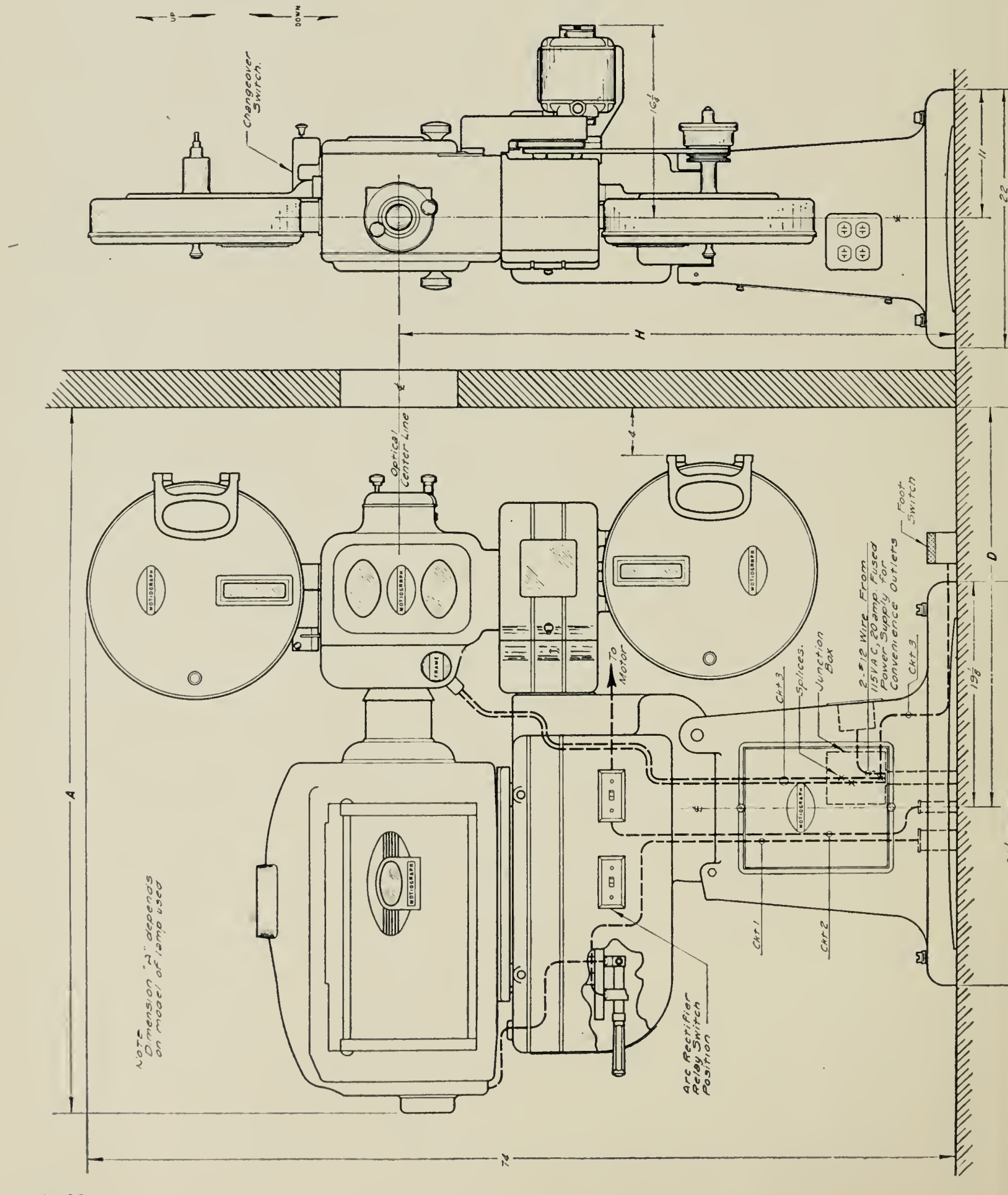
General ventilation of the projection, rewind and power equipment rooms should be provided by an exhaust system having a capacity of not less than two hundred cubic feet per minute and an auxiliary emergency capacity of at least one thousand cubic feet per minute for operation in case of fire. This system should have at least two ceiling grill outlets in the projection room, and is not to be interconnected with any other ventilating systems of the theatre. Control of emergency operation will be by means of a switch operated automatically by the port shutter control, when the latter is started manually, or by the melting of the fusible links in such control. In addition to the emergency control in the shutter system, provision should be made for the manual operation of this exhaust fan from a point just outside the projection room.

An independent ventilation system should be provided for the carbon arc lamps. Over the arc lamps employed with the projectors and over the effect machines a hood should be placed which connects by a flue to a common duct leading directly out of doors. This carbon arc exhaust system should be operated by an exhaust fan or blower having a capacity of at least fifty cubic feet of air per minute for each arc lamp to which it is connected. The system should be electrically connected to the projection room wiring system, and also controlled by a separate switch with a pilot light within the room. Ventilation may be reduced as required to each projector or other

NOTE: Dimension 'D' is based on 4" magazine clearance from front wall.

PROJECTION ANGLE	H	D
16	56¾	34 3/16
14	55 3/16	34 1/16
12	53¾	34¼
10	52 13/16	34¼
8	51 9/16	34 3/16
6	50 11/16	34¼
4	49⅜	34⅛
2	48½	34
0	47⅜	33 13/16
2	46¼	33 15/16
4	45 5/16	35 5/16
6	44¼	37 3/16
8	43 7/16	38⅜
10	41¾	40 5/16
12	40 11/16	41¼
14	38 13/16	42 13/16
16	37 3/16	44¼
18	35 9/16	45⅜
20	34 3/16	46⅜

UP — DOWN



SSK-687

machine by means of a damper on the lamp house or between the lamp house and the projection room ceiling.

A fresh air supply to the projection room should be provided by two or more intake ducts located at or near the floor. This system is to be connected into the main ventilating system of the theatre, and independent of any of the exhaust systems of the projection booth.

the projection room is not the place to start saving pennies, for here the ultimate success or failure of the theatre will be largely determined.

All tables, racks, shelves and other furniture in the projection booth should be of metal in order to lessen the fire hazard. In the projection room itself there should be a metal container for hot carbon stubs. The rewind room will have a fireproof film

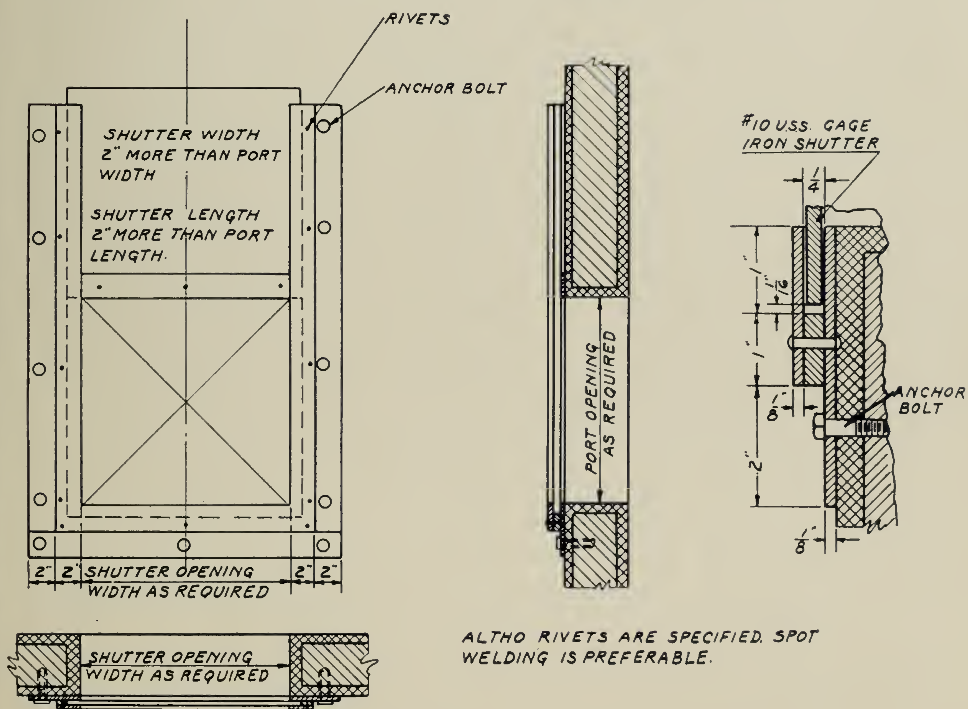


Diagram showing example of port shutter construction.

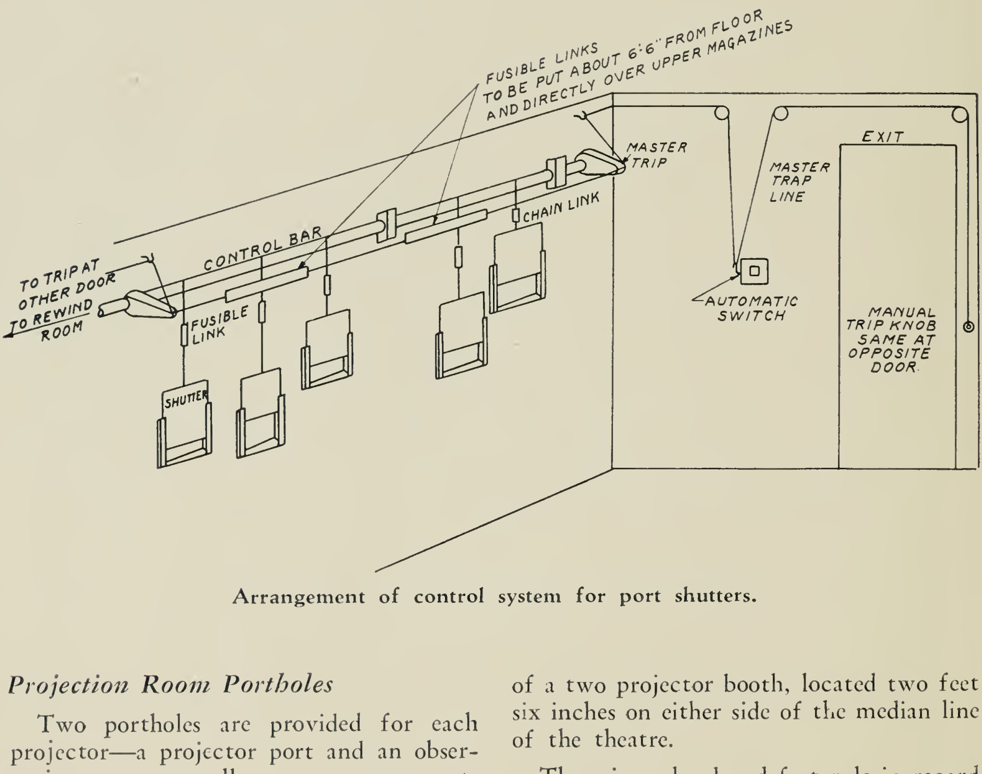
A good theatre will have a good projection booth and good equipment. No discussion of a model projection room would be complete without stressing the vital importance of projectors and sound systems and arc lamps and other major equipment, and it is regrettable that space requirements do not permit us to cover this subject as it deserves. Let it suffice to say that cabinet sufficienly large for the requirements of the theatre. The film cabinet should be vented to the outside air by means of a gravity vent constructed of noncombustible material, or, if the capacity is in excess of fifty pounds of film, be equipped with an automatic sprinkler head connected with the theatre water supply.

A good rewind room will also contain a

metal rewind table, an approved type of rewind equipment and a mechanical film splicer. The film-scrap can should keep the scraps of film immersed in water at all times, and be provided with an automatic self closing lid. Film should be kept in the film cabinet at all times except when being projected or rewound, and stocks of inflammable chemicals and other materials reduced to a minimum.

position. In the event of a greater angle of tilt, the height of the projection ports must be corrected accordingly, as indicated in the table given elsewhere in this article.

The finished projection ports should be about ten inches square, measured on the inside wall. When the vertical projection angle is zero, the horizontal center line of the ports should be four feet from the floor, with the vertical center line, in the case



Arrangement of control system for port shutters.

Projection Room Portholes

Two portholes are provided for each projector—a projector port and an observation port—as well as one or more ports for the effect machines when these are present. There are certain specifications for all of these types of portholes.

The location of the projection portholes is governed by the make and design of the projection and sound equipment, and by the vertical projection angle. As the ideal vertical projection angle is zero, all measurements given herein from the floor to the center of the ports are based upon that

of a two projector booth, located two feet six inches on either side of the median line of the theatre.

There is no hard and fast rule in regard to the dimensions of the observation port, although a size of about 14 inches wide by 12 inches high is recommended. The horizontal center line of the observation port should be 4 inches above that of the projection port, and its vertical center line 18 inches to the right of that of the projection port. The bottoms of all ports should be beveled 15 degrees downward, and if the wall is more than 12 inches thick, the sides

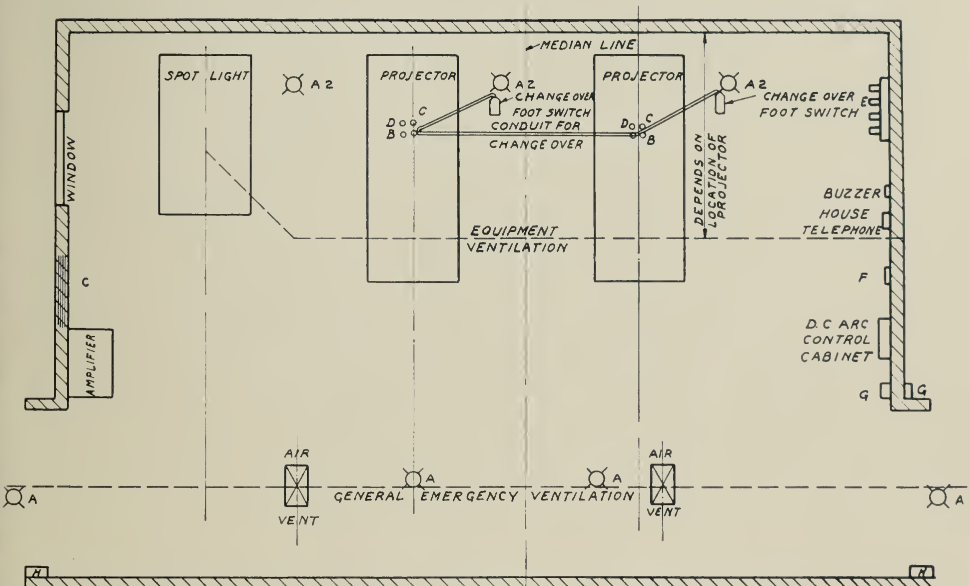
should also be beveled outward at a similar angle.

One port will serve both for projection and observation as regards the spotlight or effect machine. These ports will be as small as is practicable, with the size determined by the type of machine.

If there is a separate rewind room, it should be provided with an observation port of the same size and height as those in the projection room. There should also be a glass observation window between the rewind room and the projection room, fixed in a fireproof frame.

To prevent machine noise and sound from the monitor entering into the auditorium, the projection ports should be fitted with optical glass, and the observation ports with a good grade of plate glass. This glass should be removable for cleaning. It is highly important that the optical glass be set in the projection ports so that the plane of the glass will be at an exact ninety degree angle to the projection optical center line. Strict adherence to this suggestion will minimize reflection and give maximum light on the screen. It may be mentioned that some theatres have eliminated glass entirely from the projection ports, and endeavor to diminish the transmission of noise by reducing the size of the port or by the use of fireproof acoustical materials.

All ports must be protected by gravity



A VAPOR PROOF CEILING LIGHTS.
A2 VAPOR PROOF CEILING LIGHTS AND REELITES.
B CONDUIT IN FLOOR TO D.C. CONTROL PANEL AND MOTOR GENERATOR
C CONDUIT TO WATER PIPE GROUND FOR EACH PROJECTOR.
D TWO CONDUITS IN FLOOR TO A.C CONTROL CABINET·FOR PILOT LIGHT, CHANGE OVER AND MOTOR FEED
E DIMMER AND EMERGENCY LIGHTING CONTROL
F PROJECTOR AND SPOT VENTILATING SYSTEM AND CONTROL SWITCH
G GENERAL VENTILATION SYSTEM WITH SWITCHES INSIDE AND OUTSIDE DOORS.
H WALL SWITCHES TWO WAY TYPE INDIVIDUALLY CONTROLLING CEILING LIGHT FIXTURES FROM EITHER DOOR

Wiring diagram of projection room floor.

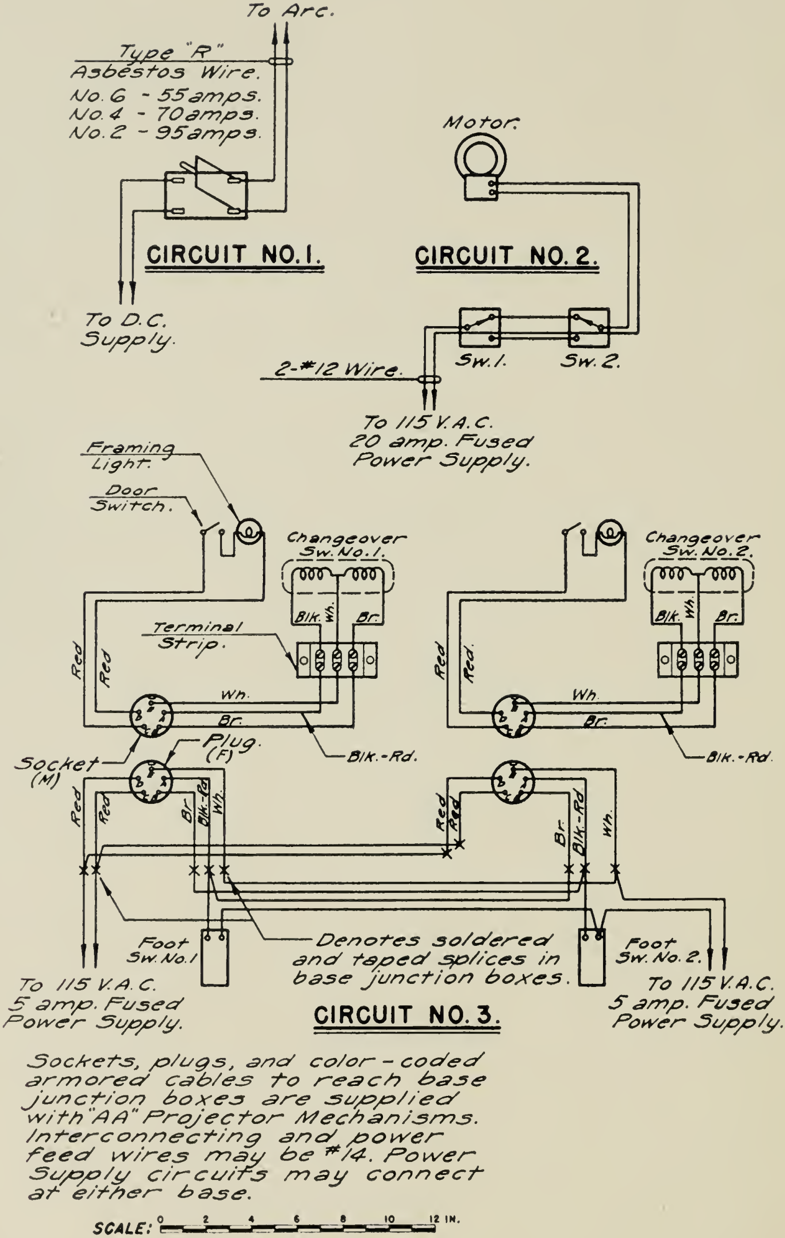
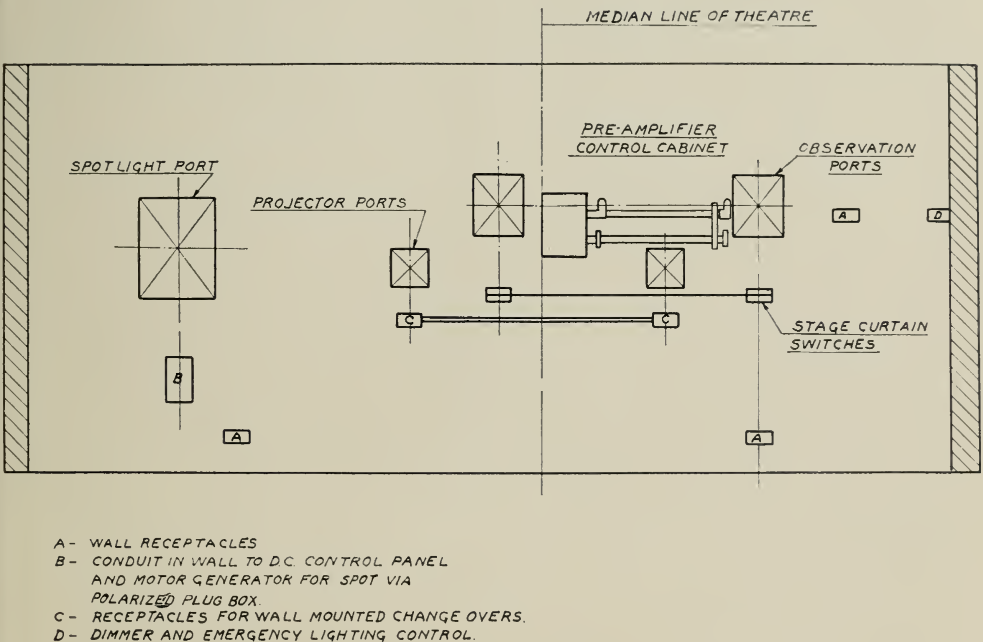


Diagram of wiring on Motiograph Model "AA" base

shutters made of No. 10 gauge iron and set in iron guides one or more inches wide at the sides and bottom. When closed, the shutter must overlap the top of the port by at least one inch. For complete fire protection, all shutters must be interconnected so that they will close simultaneously upon the operation of a mechanical releasing device or the operation of a fusible link. Each shutter must have its individual fusible link above it, and a fusible link shall be located as well above each upper projector magazine which upon operation closes all of the port shutters. The projectionist must be able to close the shutters manually from any projector head and from each exit. The shutters should be kept closed when not in use, and some theatres close all shutters at the end of the show as a means of testing their operation.

Electrical Conduits and Circuits

The location of the projectors should previously be determined so that the electrical conduits may be properly located under the projector bases. When the booth is provided with two projectors, their exact centers should be two feet six inches on either side of the median line of the theatre. The only variance in the location of projectors will be the distance from the center of the projector base to the front wall, which will vary from thirty inches to 43 7/16 inches, depending upon the angle of tilt of the projectors and the type of sound reproducers to be used. All Motiograph projectors and most other standard projectors of modern design have an opening in the base long enough to provide for this variance. The conduits for arc lamps and projectors therefore may be installed thirty inches from the front wall, regard-



Wiring diagram of the front wall of projection room.

less of the make of projectors to be used, if the angle of tilt is eleven degrees or less. For every one degree increase over this angle, the conduit openings should be moved back one additional inch. If other booth equipment is to be employed, the manufacturers should be consulted for proper conduit layouts before the booth wiring is completed.

In wiring the projection booth, conduits should be provided for the following:

1. Projectors and arc lamps.
2. Spotlight or effect machines.
3. Sound equipment.
    a. Ground wiring.
    b. Amplifier and controls.
    c. Loud speaker circuits.
    d. AC power supply.
4. Rheostats, generators or rectifiers.
5. Projection room lighting.
6. Arc lamp ventilating equipment.
7. General ventilation equipment.
8. Miscellaneous.
    a. Curtain.
    b. Receptacles.
    c. Telephone.
    d. Buzzers and signal system.
    e. Clock outlet.

All of the specifications and details given in this article are of course intended only to serve as a guide for the construction of an ideal projection booth. It will be understood that at times certain difficulties will arise to prevent these specifications from being carried out in every detail. That is a matter to be left in the hands of the theatre architect. He is fully qualified to determine what will best accomplish the essential purpose of satisfactory picture presentation.

NOTES TO THE PROJECTIONIST

Before resumption of service after complete or partial power failure, it's wise to disconnect all line switches to motors, generators, rectifiers and other electrical equipment. The simultaneous starting of all equipment will cause overloads and may result in damage to equipment.

Upon resumption of complete service, check to see that three phase equipment is operating on all three phases and not "single phasing," which may result from the blowing of one of the three fuses.

Upon resumption of service, switches should be connected and equipment then checked for proper operation.

• • •

The projectionist should always have on hand an ample supply of fuses of all ratings and types used. It is a good idea to mark along the side of each fuse socket the rating of the fuse to be used.

Motor generator sets should never be located in the theatre basement, but rather in a room immediately adjacent to the projection room proper. This permits the projectionist's constant observation, and keeps the parts dry.

• • •

All power wiring is grounded to the earth at original installation, generally through the medium of a water pipe. This connection should be examined periodically for possible corrosion.

• • •

Should there be occasion to make changes in projection room wiring, employ conduits larger than may be immediately necessary. This precaution may save a costly rewiring job in the future.

• • •

Inspect fuses, switches, bus bars and wire connections regularly.

SCREEN CHART

FIGURES IN TABLE SHOW ACTUAL WIDTH OF PICTURE IN FEET AND INCHES

All figures are based on standard aperture of .825" x .600"

LENS FOCAL LENGTH, INCHES

PROJECTION DISTANCE, FEET (From projector aperture to center of screen)	2	2¼	2½	2¾	3	3¼	3½	3¾	4	4¼	4½	4¾	5	5¼	5½	5¾	6	6¼	6½	6¾	7
40	16' 4"	14' 6"	13' 1"	11'10"	10'10"	10' 0"	9' 3"														
50	20' 6"	18' 2"	16' 4"	14'10"	13' 7"	12' 7"	11' 8"	10'10"	10' 2"	9' 7"											
60	24' 7"	21'10"	19' .8"	17'10"	16' 4"	15' 1"	14' 0"	13' 1"	12' 3"	11' 6"	10'10"	10' 3"	9' 9"								
70	28' 9"	25' 6"	23' 0"	20'10"	19' 1"	17' 8"	16' 4"	15' 3"	14' 4"	13' 5"	12' 8"	12' 0"	11' 5"	10'10"	10' 4"	9'11"					
80	32'10"	29' 2"	26' 3"	23'10"	21'10"	20' 2"	18' 9"	17' 6"	16' 4"	15' 5"	14' 6"	13' 9"	13' 1"	12' 5"	11'10"	11' 4"	10'10"	10' 5"	10' 0"		
90	37' 0"	32'10"	29' 7"	26'10"	24' 7"	22' 9"	21' 1"	19' 8"	18' 5"	17' 4"	16' 4"	15' 6"	14' 9"	14' 0"	13' 4"	12' 9"	12' 3"	11' 9"	11' 3"	10'10"	10 6"
100	41' 1"	36' 6"	32'10"	29'10"	27' 4"	25' 3"	23' 5"	21'10"	20' 6"	19' 3"	18' 2"	17' 3"	16' 4"	15' 7"	14'10"	14' 3"	13' 7"	13' 1"	12' 7"	12' 1"	11' 8"
110	45' 3"	40' 2"	36' 2"	32'10"	30' 1"	27' 9"	25' 9"	24' 1"	22' 7"	21' 3"	20' 0"	18'11"	18' 0"	17' 2"	16' 4"	15' 8"	15' 0"	14' 5"	13'10"	13' 4"	12'10"
120	49' 4"	43'10"	39' 6"	35'10"	32'10"	30' 4"	28' 2"	26' 3"	24' 7"	23' 2"	21'10"	20' 8"	19' 8"	18' 9"	17'10"	17' 1"	16' 4"	15' 8"	15' 1"	14' 6"	14' 0"
130	53' 6"	47' 6"	42' 9"	38'10"	35' 7"	32'10"	30' 6"	28' 6"	26' 8"	25' 1"	23' 8"	22' 5"	21' 4"	20' 3"	19' 4"	18' 6"	17' 9"	17' 0"	16' 4"	15' 9"	15' 2"
140	57' 7"	51' 2"	46' 1"	41'10"	38' 4"	35' 5"	32'10"	30' 8"	28' 9"	27' 0"	25' 6"	24' 2"	23' 0"	21'10"	20'10"	19'11"	19' 1"	18' 4"	17' 8"	17' 0"	16' 4"
150	61' 9"	54'10"	49' 4"	44'10"	41' 1"	37'11"	35' 3"	32'10"	30'10"	29' 0"	27' 4"	25'11"	24' 7"	23' 5"	22' 4"	21' 5"	20' 6"	19' 8"	18'11"	18' 2"	17' 6"
160	65'10"	58' 6"	52' 8"	47'10"	43'10"	40' 6"	37' 7"	35' 1"	32'10"	30'11"	29' 2"	27' 8"	26' 3"	25' 0"	23'10"	22'10"	21'10"	21' 0"	20' 2"	19' 5"	18' 9"
170	70' 0"	62' 2"	56' 0"	50'10"	46' 7"	43' 0"	39'11"	37' 3"	34'11"	32'10"	31' 0"	29' 5"	27'11"	26' 7"	25' 4"	24' 3"	23' 3"	22' 4"	21' 5"	20' 8"	19'11"
180	74' 1"	65'10"	59' 3"	53'10"	49' 4"	45' 7"	42' 3"	39' 6"	37' 0"	34'10"	32'10"	31' 2"	29' 7"	28' 2"	26'10"	25' 8"	24' 7"	23' 7"	22' 9"	21'10"	21' 1"
190	78' 3"	69' 6"	62' 7"	56'10"	52' 1"	48' 3"	44' 8"	41' 8"	39' 1"	36' 9"	34' 8"	32'10"	31' 3"	29' 9"	28' 4"	27' 1"	26' 0"	24'11"	24' 0"	23' 1"	22' 3"
200	82' 4"	73' 2"	65'10"	59'10"	54'10"	50' 8"	47' 0"	43'10"	41' 1"	38' 8"	36' 6"	34' 7"	32'10"	31' 3"	29'10"	28' 7"	27' 4"	26' 3"	25' 3"	24' 4"	23' 5"
220		80' 6"	72' 6"	65'10"	60' 4"	55' 9"	51' 9"	48' 3"	45' 3"	42' 7"	40' 2"	38' 1"	36' 2"	34' 5"	32'10"	31' 5"	30' 1"	28'11"	27' 9"	26' 9"	25' 9"
240			79' 1"	71'10"	65'10"	60' 9"	56' 5"	52' 8"	49' 4"	46' 5"	43'10"	41' 7"	39' 6"	37' 7"	35'10"	34' 4"	32'10"	31' 7"	30' 4"	29' 2"	28' 2"
260			85' 8"	77'10"	71' 4"	65'10"	61' 2"	57' 1"	53' 6"	50' 4"	47' 6"	45' 0"	42' 9"	40' 9"	38'10"	37' 2"	35' 7"	34' 2"	32'10"	31' 8"	30' 6"
280				83'10"	76'10"	70'11"	65'10"	61' 6"	57' 7"	54' 3"	51' 2"	48' 6"	46' 1"	43'10"	41'10"	40' 0"	38' 4"	36'10"	35' 5"	34' 1"	32'10"
300					82' 4"	76' 0"	70' 7"	65'10"	61' 9"	58' 1"	54'10"	52' 0"	49' 4"	47' 0"	44'10"	42'11"	41' 1"	39' 6"	37'11"	36' 6"	35' 3"
320						81' 1"	75' 3"	70' 3"	65'10"	62' 0"	58' 6"	55' 5"	52' 8"	50' 2"	47'10"	45' 9"	43'10"	42' 1"	40' 6"	39' 0"	37' 7"
340							80' 0"	74' 8"	70' 0"	65'10"	62' 2"	58'11"	56' 0"	53' 3"	50'10"	48' 8"	46' 7"	44' 9"	43' 0"	41' 5"	39'11"
360								79' 1"	74' 1"	69'10"	65'10"	62' 5"	59' 3"	56' 5"	53'10"	51' 6"	49' 4"	47' 6"	45' 7"	43'10"	42' 3"
380								83' 6"	78' 3"	73' 8"	69' 6"	65'10"	62' 7"	59' 7"	56'10"	54' 5"	52' 1"	50' 0"	48' 1"	46' 4"	44' 8"
400									82' 4"	77' 6"	73' 2"	69' 4"	65'10"	62' 9"	59'10"	57' 3"	54'10"	52' 8"	50' 8"	48' 9"	47' 0"

To find picture height, multiply width by .73

To determine size of screen, add at least 6 inches to width and height.

Safety in the Booth

How Chicago Regulates Its Theatres

By SAMUEL R. TODD
Examiner, Moving Picture Machine Operators, City of Chicago

Every so often some one asks me how to prevent fires in the motion picture projection booth. My opinion is that the best way to deal with fires is not to have any. It can be done, because we have been doing it for a long time in Chicago.

Thirty years ago—when I first took over, and we began to make a real effort to regulate projection booths and projectionists—there were as many as ten to twelve fires a week in Chicago theatres. Within three years, we cut that down to an average of two fires a month. At the present time, we have about six fires a year, none of which are of any consequence. As a matter of fact, there has never been a theatre burned down or a loss of life due to fire from defective electrical wiring or film ignition in Chicago in the last twenty years.

Samuel R. Todd

We are very proud of that record. It has been compiled through a careful regulation of booth construction and wiring and a careful licensing of projectionists, plus frequent inspections to make sure that all the rules are being complied with. The Chicago code of motion picture regulation has attracted so much favorable attention that it has often been copied in other cities, and I am occasionally called upon to approve the booth plans for theatres being constructed outside of the city.

Thirty Years Ago

Booth regulation has made tremendous strides in the last thirty years. Looking back over the years, I can perceive notable improvement in virtually every phase of motion picture projection. For instance, in the early days there was no uniform wiring system, nor, in fact, much cf a system at all. If a fuse was blown on the motor circuit, the projectionist and manager would start trying out the fuse boxes in the box office and back stage, and then probably locate the right box down in the basement a half hour later.

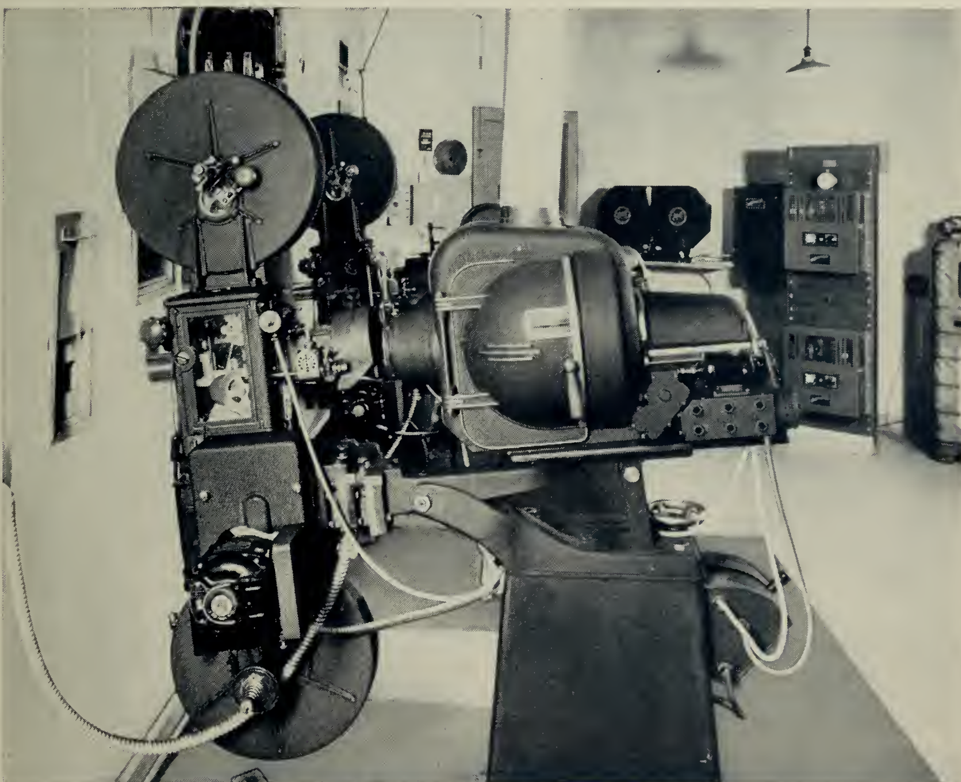
Film containers in the early days were just bread boxes, and when I use the term I mean just that, because they had the word "Bread" stamped on the covers. One of the first jobs that we had to do was to see that fireproof film containers were installed in all booths.

Another of our early improvements was the installation of an enclosed type of rewind. The resistance to this forward step, which was offered by some exhibitors, was overcome by firm insistence on compliance.

As time went on, we met problems as they arose. The first sound system in Chicago was installed at McVicker's Theatre, and none of us knew very much about it at the time. I told them to go ahead and install it, and from that point we proceeded to work out a system of wiring based on safety and efficiency.

operator in another city for one year or longer, and is qualified to pass a stiff examination.

We pay a great deal of attention to wiring regulations. I have personally examined the blueprints and supervised the wiring installation of every booth in Chicago. Building code regulations provide for fire-



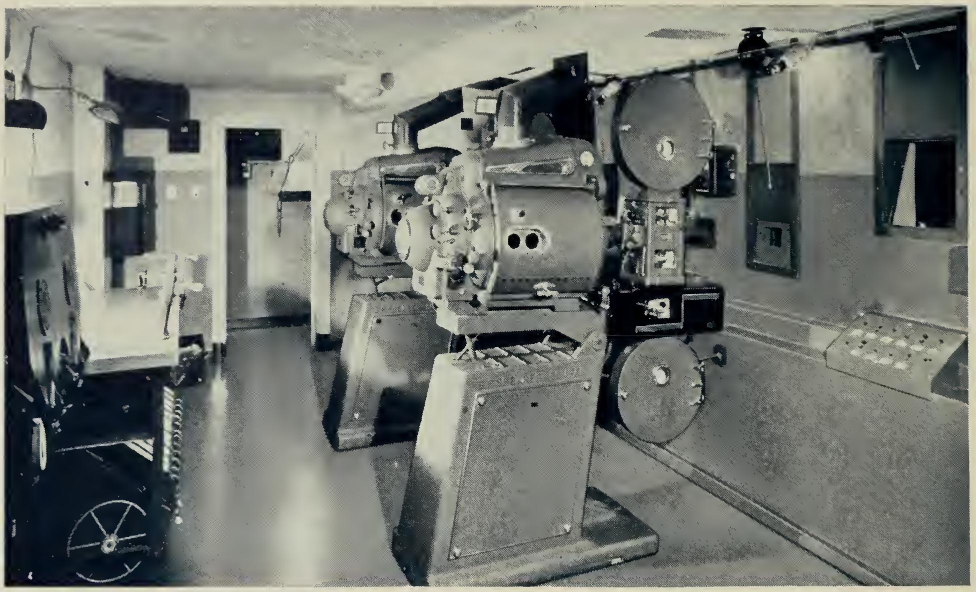
Spacious and spotlessly clean—projection room of the Ellicott Theatre, Ellicott City, Md.

Factors of Safety

There is no great secret as to how we have built up our record in Chicago. For one thing, there has been a careful licensing of projectionists. No man is allowed to work in a projection booth unless he has served an apprenticeship, or has been an

proof construction, and the fire department checks for all fire fighting safety provisions.

The projectionist can do much to help by careful examination and maintenance of his equipment. When a projectionist thoroughly understands his equipment and takes good care of it, he not only gives the



The compact and neat booth arrangement of the Times Theatre, Sacramento, Calif.

patrons of his theatre a better show, but he lessens the possibilities of breakdowns and of fires.

All in all, we feel that we have the situation pretty well under control in Chicago. Under our present regulations, there no longer is any danger of patrons being burned in a theatre fire. Our main idea is to confine any fire to the booth and to prevent smoke from getting into the theatre, which might give rise to a panic.

Projector Regulations

Let us glance at some of the provisions of the City of Chicago code regarding motion picture projectionists, booths and equipment.

The professional types of projectors, such as are commonly used in theatres and motion picture houses, shall be located in fireproof enclosures as required by the code of the department of buildings.

The arc lamp house shall be composed entirely of metal having a thickness not less than No. 24 U.S. sheet metal gauge (.025 inch), except where the use of approved insulating material is necessary. An automatic overload protective device and a manually operable switch shall be provided for each ungrounded conductor supplying the lamp. Incandescent lamp enclosures shall conform to the above requirements as far as may be practicable. Arc or incandescent lamp enclosures shall be marked with the name of the maker and with the current and voltage rating for which they are designed.

The enclosure for the arc switch on the projector shall be of metal of a thickness not less than No. 16 U.S. sheet metal gauge (.0625 inch).

Wires not smaller than No. 4 shall be employed to supply the projector outlet in a theatre. Wiring shall, in all cases, be installed for the full rated current of the lamp to be used.

Rheostats, transforming devices and any substitute therefore shall be of types ex-

pressly designed and approved for the purpose.

Top and bottom magazines shall be so designed with a rabbet on the inside or a flange on outside of the door in such a manner as to prevent the entrance of flame and for the purpose of reinforcing the door. No solder shall be used in their construction. The front side of each magazine shall consist of a door swinging horizontally and equipped with a substantial latch. The top and bottom magazines shall be constructed of metal, reinforced in an approved manner and having a thickness not less than No. 22 U.S. sheet metal gauge (.032 inch). Top and bottom magazines shall be equipped with fire trap and fire rollers approved by the division of electrical inspection.

An automatic shutter shall be provided and permanently attached to the gate frame. The construction of the shutter shall be such as to shield the film from the beam of light whenever the film is not running at operating speed.

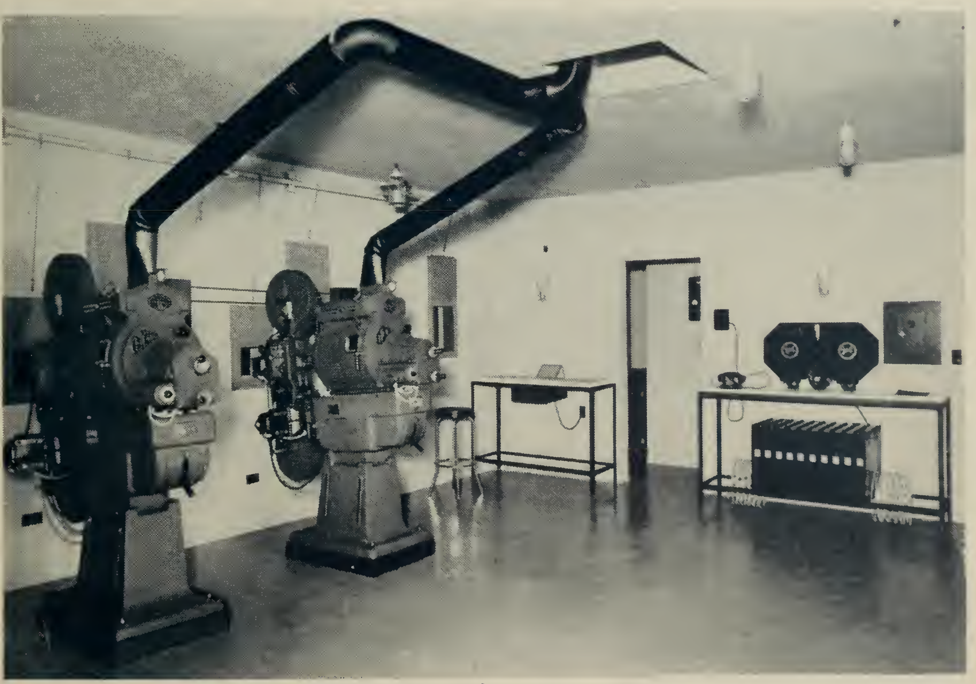
Motion picture projectors shall be so constructed that the film shall be entirely enclosed within the magazines, the machine head and the sound head, except at the aperture during operation.

The optical shutter on the projector head shall be so mounted as to intercept the beam of light between the source of light and the aperture.

The projector shall be equipped with a film take-up device approved by the division of electrical inspection.

In the top and bottom magazines there shall be a clearance of not less than one inch between the outer edge of the reel and the inner wall of the magazine.

Reels containing more than 2000 feet of film capacity shall not be used.



Few theatres are provided with projection rooms as spacious as that pictured above.

The Projection Room

Plans for the projection room shall be submitted to the division of electrical inspection for approval before any construction is started. These plans shall show the dimensions of the projection room, the layout of all wiring and location of all electrical equipment; also shall show the location and size of all openings in the walls and ceilings. Rigid conduit or electrical metallic tubing shall be employed as the wiring method. Conduits shall be concealed and all boxes shall be of the flush mounting type. One outlet connected to the emergency lighting system shall be installed in the projection room. Motors, generators, rotary converters, rectifiers, rheostats and sound amplifying equipment shall be marked with the name of the maker and with the current and voltage rating for which they are designed. Facing the picture screen, there shall be a spacing of not less than forty-two inches between the lens center of the right hand projector and the right end wall, sixty inches between lens centers of projectors and forty-eight inches between lens center of left hand projector and left end wall. There shall be a spacing of not less than forty-eight inches between other light projectors. The projection room inside dimensions shall be not less than ten feet from front wall to rear wall, twelve feet six inches between end walls and eight feet six inches between the floor and the ceiling.

In addition to the gravity vent required by the code of the building department of the City of Chicago, there shall be provided, when the port holes are closed, an out draft of air in each projection room by means of an air duct and an exhaust fan having a capacity of at least 200 cubic feet of air per minute for each 80 square feet of floor area of the projection room. The exhaust fan motor shall be so installed that fumes passing through the exhaust air duct cannot come in contact with the motor. Current for the motor shall be supplied from the general lighting panel. There shall be a dual switch control for this motor—one switch shall be so connected to the master shutter control that the exhaust fan motor will be put in operation automatically when the port hole master shutter control is released—the second switch shall be connected in parallel and be of a manually operable type and shall be located outside of the projection room near the exit door.

The doors on main openings to the projection room shall be metal clad and swing outwards and arranged to be held normally closed by spring hinges or door checks. If a door check is used it shall be located outside of the projection room. All other openings in the projection room, except the ventilator opening, shall be protected by sliding shutters constructed of sheet metal of a thickness not less than No. 14 U.S. sheet metal gauge (.0781 inch). The shutters shall be arranged to close by gravity and shall operate freely in guides which are continuous along both sides and bottoms of openings. These guides shall be built up of strap iron two inches wide and one-eighth inch thick with spacers one inch wide and twice as thick as the shutter. These shutters shall be held open by a master shutter control cord which passes over the center line of the aperture of each projector and seventy-eight inches above the projection room floor. This cord shall terminate in a metal ring placed over a steel pin at the exit door and so arranged that all shutters may be readily manually closed at either or both exit doors. An approved fusible link with a maximum rating of 165 degrees F, shall be inserted in the master cord above each projector. The metal frame for each observation or light projection opening shall be provided with a sill having a downward pitch from inside to outside. This pitch shall be not less than 30 degrees from the horizontal.

Booth Safety Factors

Rewinding of films shall be performed in the projection room. Reels carrying films in process of rewinding shall be en-

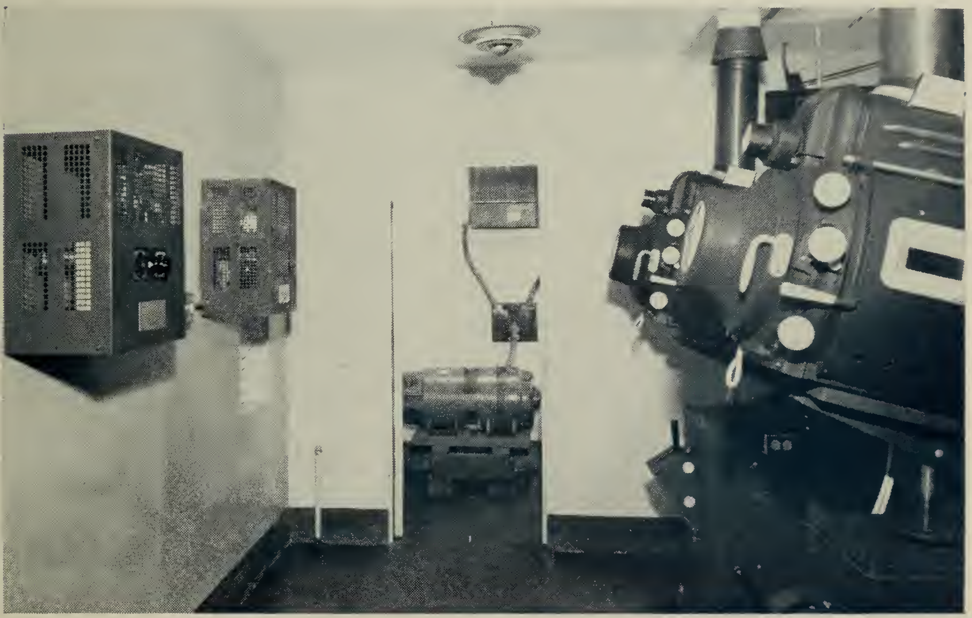
closed in magazines of approved design. The film rewind shall not be mounted within reach of the projector head.

Extra films shall be kept in approved fireproof metal cabinets designed for the storage of each reel in a separate fireproof compartment. Each compartment shall have a separate self-closing cover.

trol of a motor operating the curtain at the picture screen may be located in the projection room.

Smoking is prohibited at all times within the projection room.

The use of any fire or open light is prohibited in the projection room during the time the audience is in the building.



Generators or rectifiers should be located in a separate room.

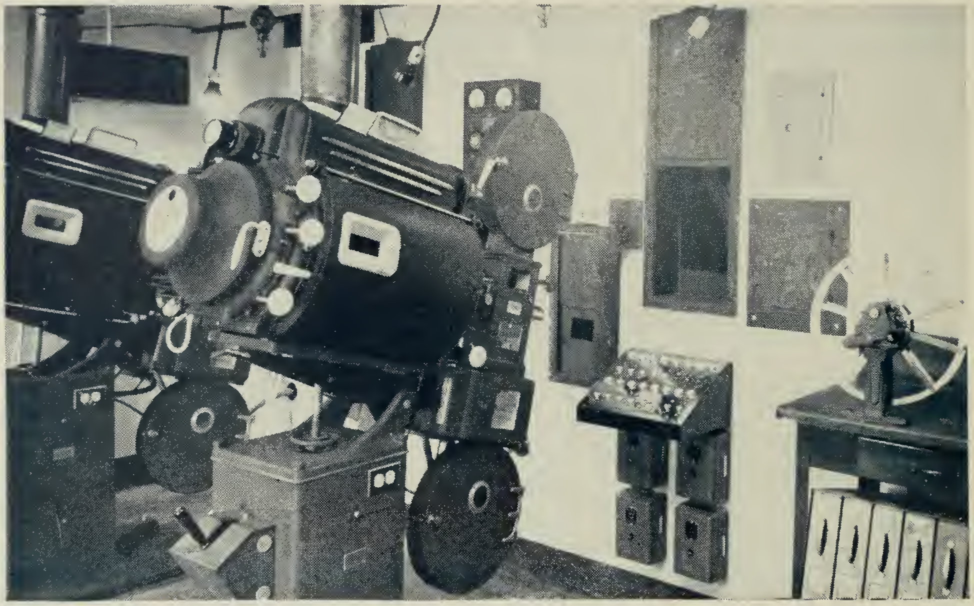
Rectifiers, motor generators, rheostats, storage batteries, switchboards, dimmers or other similar devices shall not be located in the projection room.

Each incandescent lamp not otherwise protected by non-combustible shades or enclosures shall be provided with an approved lamp guard.

No switches or controls of any kind except for the operation or control of projection, sound, or accessory projection equipment shall be located in the projection room or the generator room, provided, however, a switch or switches for the con-

The projection room shall contain nothing but the moving picture machines, the sound reproducing equipment and the necessary accessories, and the room shall be kept clean at all times.

The operator in charge of the moving picture machine shall, before every presentation, carefully examine the machine and its devices, including the films, and ascertain if the same comply with the rules and ordinances, and that the said machine is in a safe condition to operate. Also, he shall, before every presentation, examine the projection room shutters and shutter



The control panel is easily accessible.

control apparatus and ascertain if the same are in proper condition to be operated manually or automatically.

The commissioner of streets and electricity may, for any violation of the provisions of the code, or for failure to report to the chief electrical inspector any violation of the electrical code, or any rule or regulation of the department of streets and electricity, pertaining to the operation and maintenance of moving picture projecting machines or devices, suspend the license of any moving picture projecting machine operator for a period not to exceed thirty days. The Mayor may revoke the license of any moving picture projecting machine operator for the violation of any ordinance of the city relative to the use or operation of moving picture projecting machines and devices, or if in the discretion of the Mayor the holder of such license is incompetent or unfit. The Mayor may also revoke the permit of any apprentice to a moving picture projecting machine operator at any time at his discretion.

A poorly soldered connection in a power line may be a fire hazard, or at least a cause of serious trouble. How about a little detective work on all connections?

• • •

Ground connectors require periodic inspection. Sometimes it's even desirable to remove the connector to see if corrosion has set in underneath it.

The Early Years

Development of the Motion Picture Projector

By ALVAH C. ROEBUCK

Founder of Motiograph; Co-Founder of Sears, Roebuck & Co.

The motion picture projector of the present day takes on even greater interest when one traces its development over the course of the last half century.

Perhaps no one played a more significant part in the commercial development of the projector than the late Alvah C. Roebuck, founder of Motiograph and co-founder of Sears-Roebuck & Co. In the following article, written several years before his death, he gave an outline of his experiences and of the various Motiograph models prepared under his direction.

The facts presented furnish an excellent indication of the technical progress of the motion picture projector.

For some reason that I am not entirely able to comprehend, the average person seems to compare me with some sort of legendary figure of the past—a living connection, as it were, with the great bygone era when many of our giant commercial enterprises were founded. This amuses me. While not active in any business at the present time, I am certainly very active mentally in my interest in the business world of 1943.

Looking backward, I find that the intervening years were not only most interesting and exciting, but to me they are just as realistic and lifelike as today. True, many of my well known and capable associates of the past are no longer among the living, but on my occasional visits to the Motiograph plant, I still find myself greeted by former employees who worked with me in an enterprise to which I devoted a large part of my business life.

The founding of what is today known as Motiograph is so closely associated with the early history of Sears, Roebuck & Co. that I must relate something of the establishment of the "World's Largest Store". To do so requires that I tell something of myself and of my old friend and business associate, Richard Warren Sears.

Mr. Sears—equipped with a small office and but few employees—ran an advertisement for a watchmaker in the classified columns of the Chicago Daily News. A few days later I had my first meeting with Mr. Sears—and landed the job.

My relations with Mr. Sears during the next several years, while full of interest, have no direct bearing on my present story.

On April 2, 1892, Sears and I established a mail order business in Minneapolis which was known as A. C. Roebuck & Co. This name was changed to Sears, Roebuck & Co. on Aug. 23, 1893, and in January of 1895 we moved the business to Chicago.

The Beginnings of Motiograph

Now we have reached the point where Motiograph came into being. At this time there was little in the way of entertainment for residents of smaller cities and towns, other than amateur theatricals and an occasional circus. I conceived the idea of offering for sale an "entertainment outfit," by means of which the purchaser might liven up church social activities and at the same time earn some extra money for himself and for the church. As the talking machine was then a novelty, our first outfit featured a phonograph, records and all necessary accessory equipment.

Mr. A. C. Roebuck.

Motiograph really began its existence in 1896, when we switched to a magic lantern and thus entered the projection field. The complete outfit consisted of a magic lantern, a choice of several sets of from fifty-two to eighty slides, a supply of advertising posters and admission tickets, a book of instructions, etc.

Perhaps at this point the reader may indulge in a tolerant smile at the simpler amusements of the preceding generation, but let me say that the magic lantern idea was a huge success. Orders poured in from all parts of the country, and within a very short time the sale of entertainment outfits constituted an appreciable portion of our business.

It was largely that I might devote all of my time to Motiograph, then known as the Enterprise Optical Mfg. Co., that about 1897 I disposed of my interests in Sears, Roebuck & Co. to Mr. Sears. Two years later, with a feeling of sorrow and in opposition to the wishes of Mr. Sears, I resigned from the company which we had founded.

The First Movie Projector

The year 1898 marked an important era not only in the history of the company, but of the motion picture industry as well, for in that year we produced the Optigraph. I sincerely believe, after considerable research on the subject, that this was the first practical motion picture projector. I may also quote from the Modern Theatre section of Boxoffice of December 14, 1935: "Who built and marketed the first commercially practical moving picture machine? . . . The result, to our mind, is somewhat conclusively in favor of Motiograph as the daddy of the machines that turned magic lantern shows into movies."

The Optigraph was a combination motion picture projector and magic lantern. You may form an idea of what it looked like from the accompanying illustration as

well as I can describe it to you. In order to achieve a combination machine, I had conceived the idea of a hinge which permitted one to swing open the lens portion of the projector and insert the film. It was hand operated by means of a crank, while lighting was obtained by means of an incandescent lighting outfit employing gasoline. Many people may view it today with something akin to mirth, but at the time it proved itself to be a very serviceable little machine.

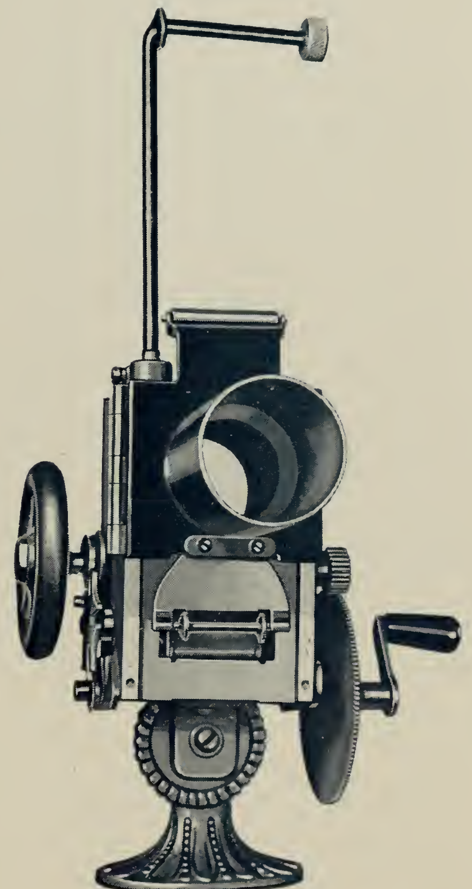
The ensuing decade constituted what might be termed a period of development. A number of improvements were made in the mechanism including a very simple and efficient framing device, while the addition of a film takeup reel provided an element of safety and greater protection for the film. All in all, the little machine was beginning to evolve along the lines of the modern projector.

Model "1A" Motiograph

Our real entry into the field of the motion picture theatre began in 1908 when we produced the Model "1A" Motiograph. In many respects it may be considered as the first high grade modern projector, and I still think it a splendid piece of equipment. It was well engineered, and I understand that in recent experimental tests it maintained a surprisingly good performance.

The principal points of the Model "1A" may be reviewed briefly. It was provided with an improved shutter, and had a very accurate Geneva movement. The projector was mounted on a strong cast iron pedestal, with a broad circular base instead of small tubular legs. The crank and stereopticon arrangement of the earlier models was retained.

The Model "1A" was the only motion picture machine of distinctive design that had been originated and constructed since the advent of the motion picture theatre. A series of changes were incorporated in new models during the succeeding years, including the first double shutter, which appeared in the Model "D." It was our constant desire to maintain our margin of superiority by means of improvements and

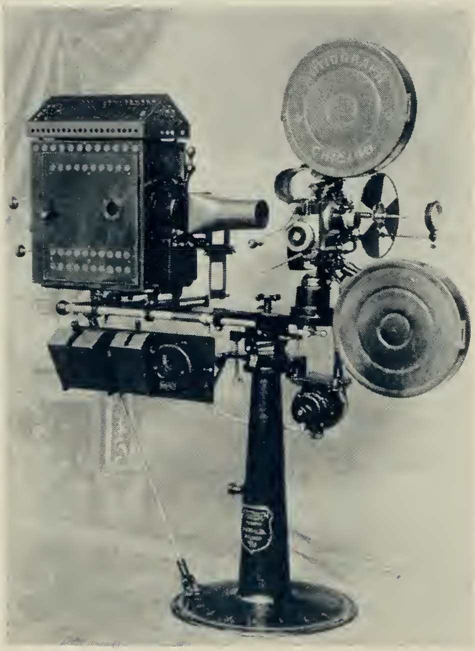


The Optigraph, generally regarded as the first practical motion picture projector.

new inventions. Nearly one hundred successful patents were issued to me.

The next really important epoch in Motiograph history was the advent of Model "E" in 1916. Let me allude to a

few of the principal developments. The motor was still operated by means of belts, but it was placed beneath the lower magazine, and was provided with a speed control, so that speed variation became absolutely mechanical and positive. A new type of condenser mount was designed to permit the removal of the lenses when hot without



Model "1A" Motiograph.

touching with the fingers. Both the stand and the magazines embodied revolutionary improvements in design and were far superior to anything else in the field. It should be noted that the shutter, the crank and the stereopticon arrangement still form integral features of the projector of that date.

A Reputation for Quality

If I may be permitted to digress at this point, I should like to say a few words about the basic principle which guided the policy of the company, and which, I may add, still guides it. It has been my belief that a combination of well made parts, efficient engineering, experienced workmanship and improved design could only result in a projector of the highest quality. When introducing the Model "E" in 1916, I endeavored to express that policy in the following terms:

"Sensational advertising claims are all too common in the marketing of projectors.

"But the daily delivery of service, easily, economically, uncomplainingly, the dependable readiness to do everything and anything that a motion picture projector ought to do when placed under exacting condi-

Model "E" Motiograph.

tions, is the supreme test of a projector.

"And this kind of service is possible only from projectors that are designed and built by builders with many years of experience in the projector industry and vast resources of organization equipment.

"The Enterprise Optical Mfg. Co. is such an organization, having been building projectors over 20 years, and we claim we have in the Motiograph De Luxe a projector unrivaled in beauty, projection and endurance.

"We realize that such a sweeping claim of superiority will not pass without a challenge.

"We know that the motion picture projector expert will demand a strict accounting from us.

"And we welcome this, for we stand ready, and our distributors everywhere stand ready, to prove our claim for perfect projection, long life and small upkeep."

Motiograph, when judged by the standards of performance and length of service, has always represented true economy in every sense of the word.

To elucidate my point, I can only point out that there are Model "F" Motiographs —made over twenty years ago—still giving good service in a number of theatres throughout the country.

I recall that when projectors were to be installed at the Field Museum in Chicago and the Municipal Auditorium in Cleveland, there was great competition among all of the manufacturers to secure the use of their products. Our two chief competitors offered their projectors without cost in order to secure the benefit of the advertising which would result. After thorough testing, Motiographs were chosen for both places—and purchased at the full price!

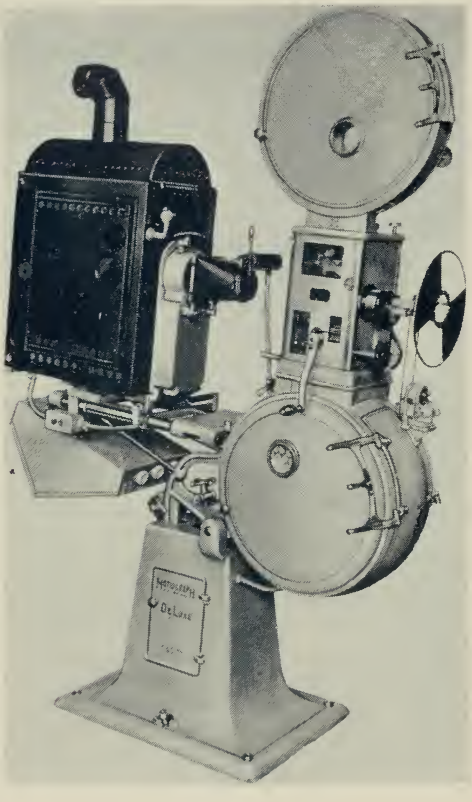
The Motiograph office during the early years of the Roebuck regime.

The Model "F"

It was in 1921 that we introduced the Model "F" Motiograph. This projector

soon established itself as the monarch of its day.

Among the many improvements presented in this model, I recall chiefly the following. For the first time, the mechanism was enclosed, which gave a decidedly improved appearance to the entire projector. There was likewise a better lens arrangement, removable bearings, and a variable speed gripping disc. While retaining the front type of shutter, it was now a two blade shutter, and with a timing device so that it could be timed while the machine was running.



Model "F" Motiograph

The projector was provided with a generator with a capacity of six volts for the pilot lamp. Much work had been devoted to the base, which had been improved for tilting. The magazines elicited much favorable commendation, and were provided with peepholes. One notes that the projector is still equipped with a crank, although the stereopticon has been enclosed.

The End of an Era

The Model "F" Motiograph—which was a marvel—was the last produced during my tenure of ownership.

After so many years in the manufacture of motion picture projectors, the increasing pressure of other interests induced me to part with Motiograph. In 1924 I sold the company, and for some years gave all of my time to my Florida realty holdings.

After nearly twenty-five years, however, one cannot entirely lose a love for the motion picture industry. I follow the progress in design of the postwar Motiograph with considerable interest, and cannot help but reflect on the tremendous progress which has marked projector design and construction during the present century. This new postwar model, I may say, with its startling developments in all respects, should prove a worthy successor to the famous Motiograph models of the past.

The Period from 1924 to 1941

One of the Motiograph officials has added a few supplementary remarks to the article by Mr. Alvah Roebuck to cover the remainder of the period prior to World War II.

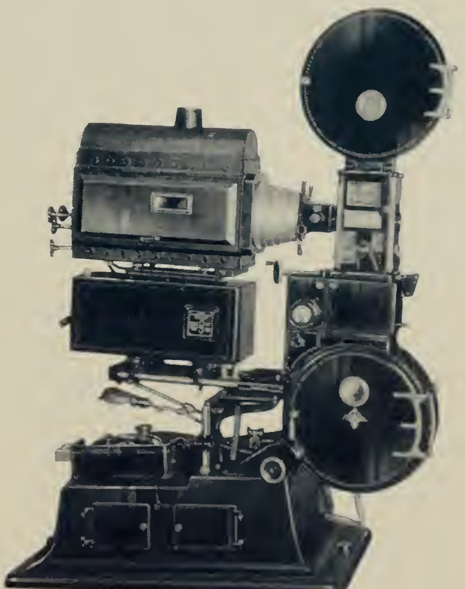
In 1924 Mr. Roebuck disposed of Motiograph, then known as the Enterprise Optical Mfg. Co., to a group consisting of Francis E. Matthews, Walter Hammons and O. M. Spahr. Mr. Spahr, who began in 1911 and was general manager at the time of the sale, was named president and entrusted with the active direction of the company.

Sound then came into the picture. Our answer was the Model "H". The greatest innovation, of course, was the new Motiograph sound system, which reproduced both sound on film and Vitaphone records.

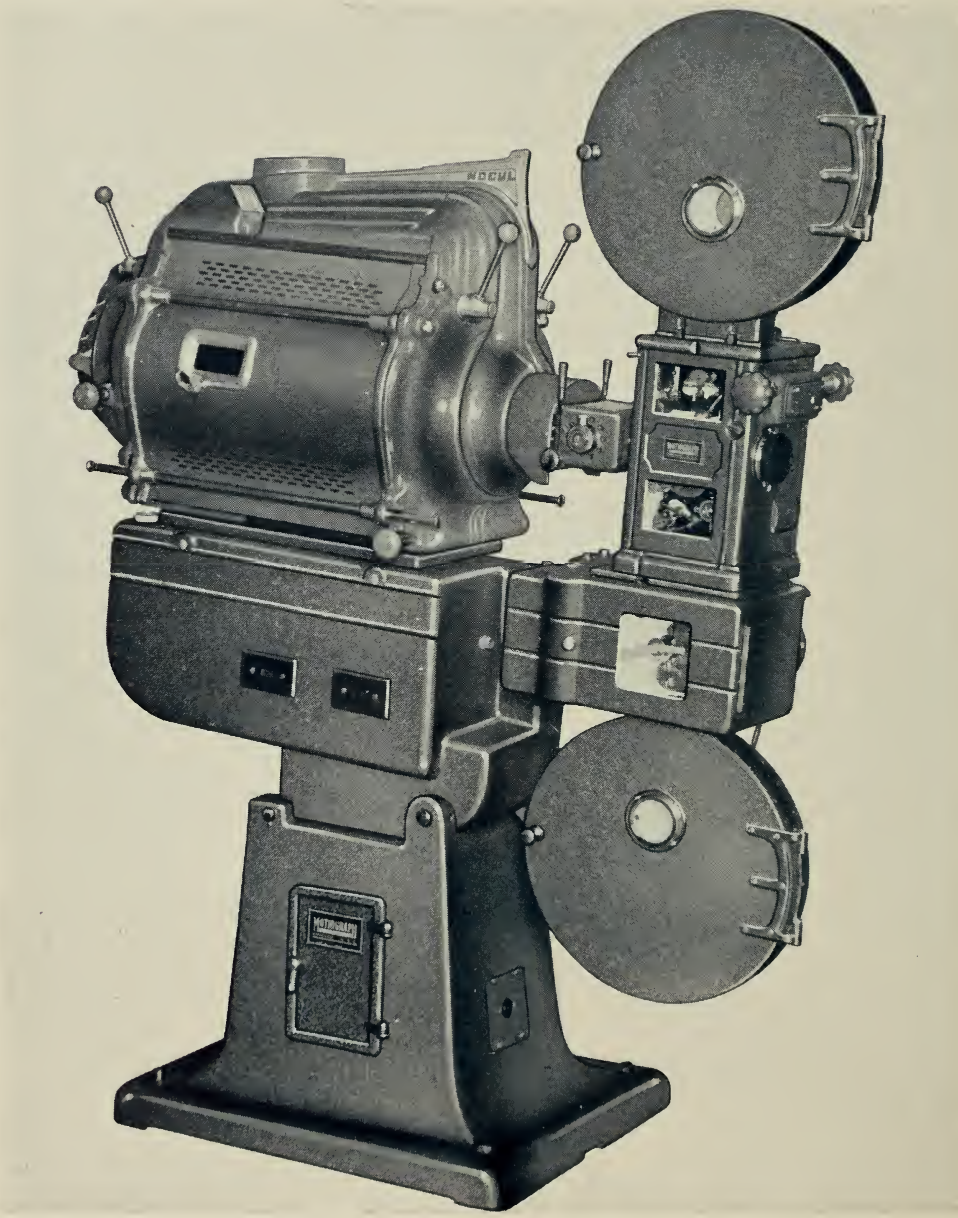
Among the principal modifications in this model were minor changes in the mechanism and a cylindrical type double blade rear shutter, which improved the light on the screen and eliminated excess heat on the film. There was a pinion framer, operated by means of a rather large wheel placed behind the lower magazine, while the installation of sound had made necessary some important modifications in the construction of the base. The projector was provided with a low intensity Motiograph arc lamp, with switch and rheostat in the box below.

This Model "H" was perhaps as well constructed as any of the Motiograph models of the past even though we were all more or less experimenting with sound at this time.

We instituted a sort of "New Deal" of our own in 1935, and since that time the Company has manifested a steady and uninterrupted progress. The Matthews family took over the interests of Mr. Spahr, who resigned from the presidency, and Mr. H. Thorwell Matthews began a period of active service. I might add that the Matthews interests secured complete control by purchasing the shares of Mr. Walter Hammons in 1937.



Model "H" Motiograph



Motiograph's Model "K."

In 1935 we also had a new projector, the Model "HU," which was really an improved model of the old model "H." This model enabled us to secure greater adaptability to sound systems of the manufacturer.

Steady Progress

By 1936 we had begun to get out of the woods and entered upon a period of rapid progress. In that year we had both a new name and a new projector.

The change of name took place on March 1st, 1936, when the Company stopped calling itself the Enterprise Optical Mfg. Co. and became known by its trade name of Motiograph.

The new projector was the well known Model "K." The main features of this piece of equipment are so well known to theatre owners and projectionists that I shall allude to them only briefly. We changed from single to double bearings, installed a one piece shutter, and made various improvements in the mechanism. The projector was provided with an improved base, and a faster framing device, located in the front of the mechanism.

Motiograph, I might add, now has a sound system comparable to any in the field. The start of the present line was made in 1938, just after we had signed an agreement with Electrical Research Products, Inc., a Western Electric Company subsidiary, which permitted the full use of the many Western Electric patents on sound reproducing systems. The Mirrophonic sound system, when combined with the fine engineering qualities of the Model "K," really made for a first class line of sound and projection equipment.

A section of the old Motiograph plant, taken about thirty years ago.

Some Old Time Projectors

From time to time The Sound Track receives some interesting letters telling of remarkable records of performance by early models of projection equipment. A few of these are reproduced.

"After reading the October issue of THE SOUND TRACK, I am prompted to write you concerning the following. Two years ago I visited a friend of mine in North Carolina, and found that he was using two Model '1A' (1908) Motiograph projectors in his theatre. He had of course used quite a bit of ingenuity in converting them to sound; but the main thing, the picture was rock-steady and as near perfect as you see in any theatre. I felt sure that you would like to know that a Motiograph 'antique' was still in operation."

JAMES DUNCAN

Cherokee Amusements, Inc.
Lenoir City, Tenn.

"This is a letter of appreciation to Motiograph 'know how' for manufacturing a masterpiece of motion picture projection and sound equipment. My employer purchased my present Motiograph projectors and sound equipment July 18, 1941, and I am proud to say that up to this writing this equipment is performing masterfully and doing a wonderful job. Parts replacements have been nil, and only a very slight wear is apparent of any component part.

"Prior to purchasing the present equipment, Mr. Coyle, my employer, had purchased in March of 1924 the Model 'F' Motiograph, and 17 years later these projectors, at a total maintenance cost of only $245.00, were pensioned for the current Model 'K' which I am now using. That is why I like Motiograph."

WAYNE E. MICKELSON

Coyle Theatre
Charleroi, Pa.

"This is a follow-up on the letter of Mr. Wayne E. Mickelson of Charleroi, Pa.

"Recently I installed the booth and sound equipment in the Roxy Theatre, Bentleyville, Pa., and in checking with the exhibitor I found it is the former equipment from the Coyle Theatre, Charleroi, Pa.

"The Model 'F' Motiograph Projectors referred to in Mr. Mickelson's letter have been removed from 'pension' and 'recommissioned' to service, at least for the duration.

"With very little adjustment they started off and again are doing a good job.

"When the exhibitor's propaganda system started working and the 'natives' found out where the equipment came from, the average comment was 'Coyle always had a good show.' This is also a plug for Western Electric Sound, which, by the way, is not so bad either.

"I guess it is not known just what the retirement age is for Motiograph. THE SOUND TRACK is well read and appreciated by the projectionists in my territory. Keep up the good work."

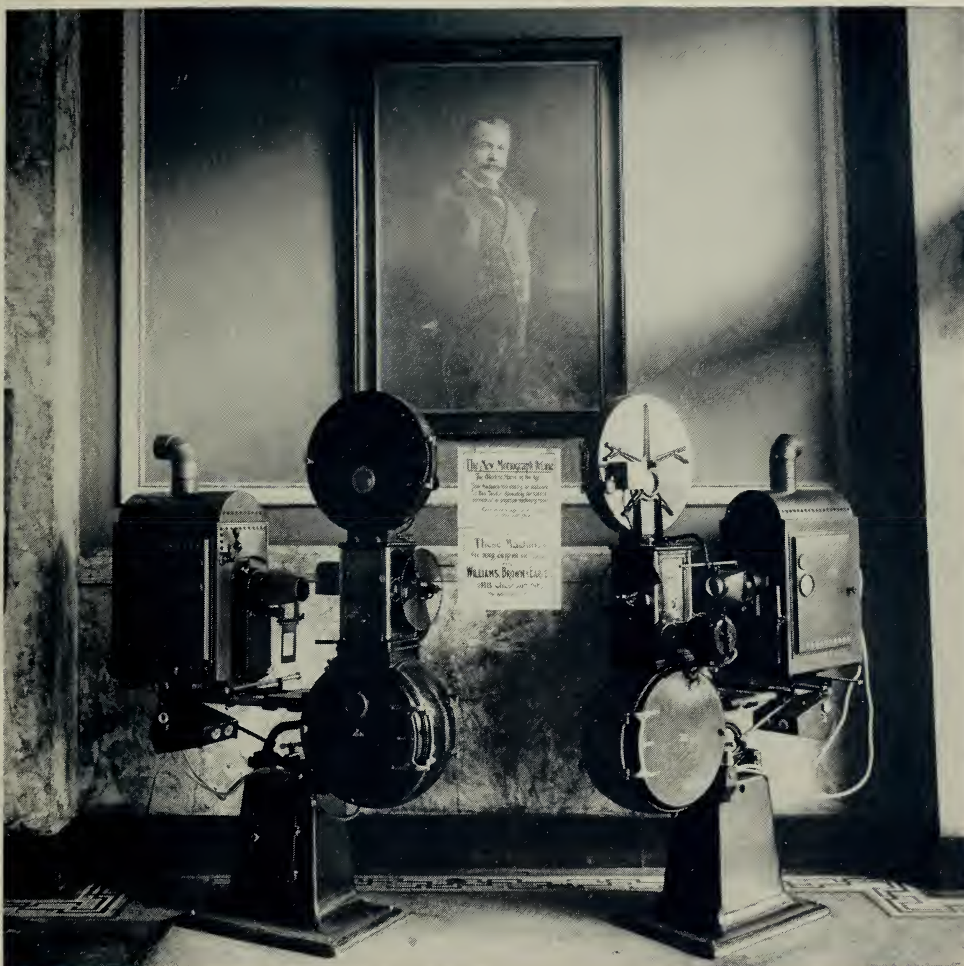
A. W. ALEXANDER
Altec Inspector

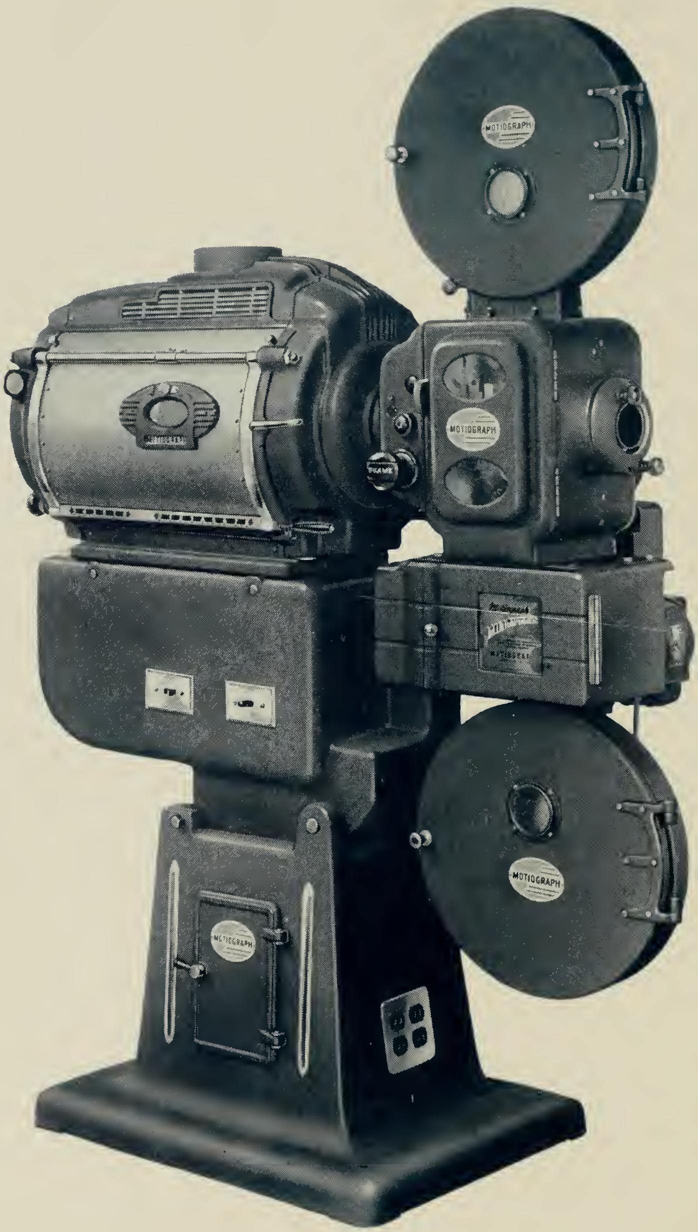
11 Jonquil Place
Mt. Lebanon
Pittsburgh 16, Pa.

"The Motiograph has always been 'tops' with me, in fact, for years. I personally installed the first super Motiograph with the high intensity arcs (G.E.) in Nixon Theatre, West Philadelphia, Pa. At that time I worked for Williams, Browne & Earle, 918 Chestnut St., Philadelphia, Pa. That was back in 1922."

GEORGE C. MEESER.

Broad St. Theatre
Nazareth, Pennsylvania.





Motiograph Model "AA."

The Present Day Projector

A Description of the Motiograph "AA"

By EMIL J. WIENKE

The Motiograph "AA" was the first of the projector models of postwar design. A description of it is therefore given in considerable detail as illustrative of the recent trends in motion picture engineering.

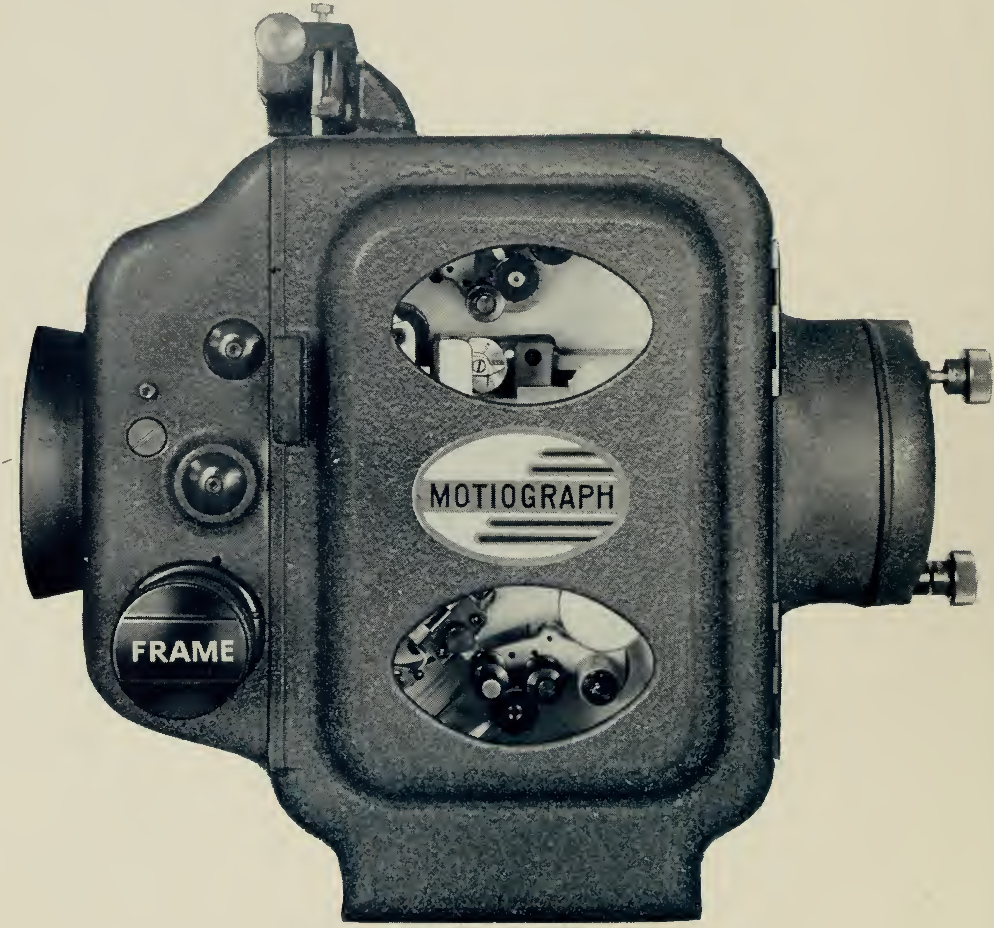
The massive streamlined housing of the Motiograph Model "AA" is a one-piece casting that encloses all the working parts of the mechanism, including the double shutter. The reinforced center frame is a part of the housing itself, which removes all possibility of vibration and resultant picture unsteadiness. The projector housing is large, being 15 inches high, 11 inches deep and 18 inches long, yet its weight is not cumbersome, since it is constructed of light but strong aluminum.

The front door is also aluminum and is provided with two windows, so that the film can be observed as it passes over the sprockets. The gear side of the housing is equipped with a dustproof aluminum cover firmly held in place by three Allen cap screws. The case, door and cover are of smooth streamlined design, with no sharp projecting corners to injure the hands or tear the clothing. The entire appearance conforms to accepted concepts of modern design.

Mechanism Construction

The Model "AA" is designed so that in case of necessity each unit or component in the entire mechanism can be quickly and easily removed, and can be just as quickly and easily replaced in its correct position. Most of the units are locked in place by Allen screws, after being located in their correct position by steel dowels solidly set in the housing. The projectionist can thus remove, and subsequently replace, tracks, shoes, apertures, lenses, gears, upper and lower feed sprockets, idler rollers, etc., in a few seconds' time. Even the intermittent sprocket can be reversed, without taking the movement from the mechanism, in less than a minute. The intermittent movement

itself can be removed from the operating side and be replaced and retimed in between reels. So simple, in fact, is the construction of the "AA" that the machine can be taken and stains. All steel gears mesh smoothly into laminated bakelite gears, which makes for unusually silent operation and exceptionally long life.



The operating side of the Motiograph "AA."

apart even down to small sub-assemblies and parts, and then be put back together in perfect working order in less than one hour.

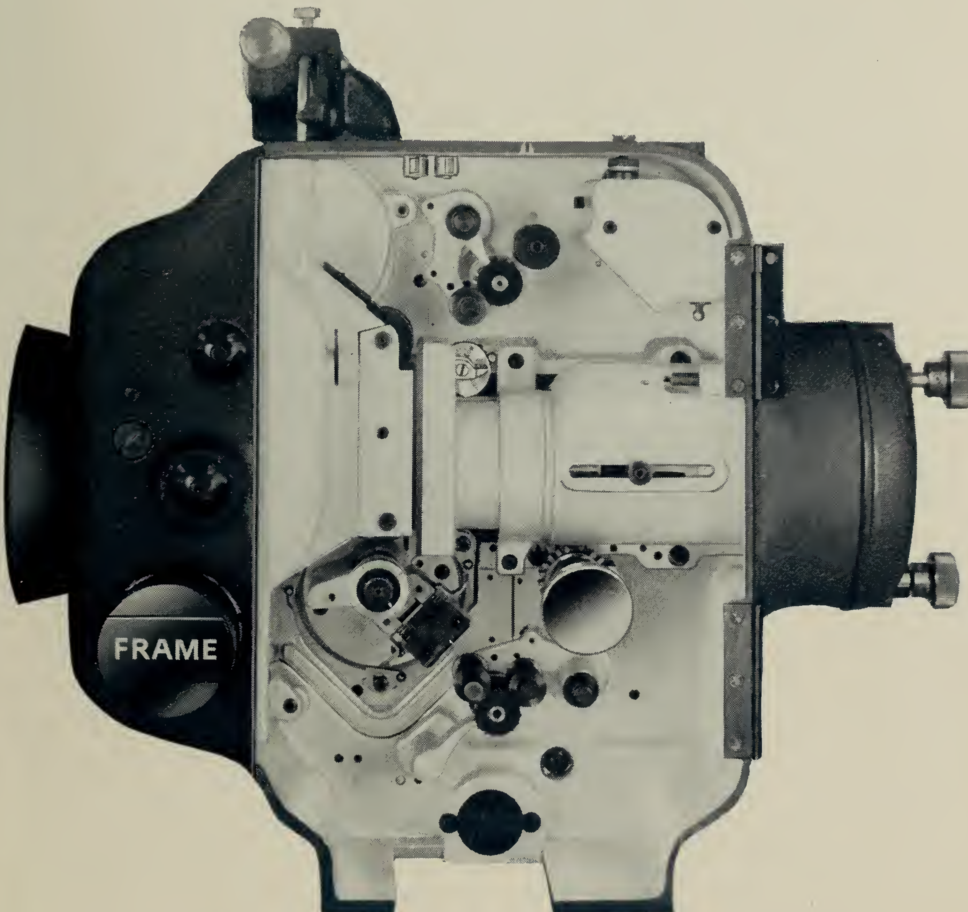
Stainless steel is utilized as the basic raw material in all parts subject to wear and handling. The liberal use of stainless steel gives added years of life to such parts, and makes them free of any possibility of rust

Lubrication

A unique feature of the Model "AA" is that all gears and shafts run freely on long-wearing double row ball bearings. These ball bearings are lubricated for their long lifetime, and there is thus no necessity for oiling and greasing at any time. The only extra lubrication required is a semi-annual greas-

ing of the intermittent movement and of the hollow pivot shafts on the two self adjusting film guide rollers. As the ball bearings, intermittent movement, and guide rollers are firmly sealed, there is no possibility of lubricant leakage, and the projector mechanism and the film remain utterly free from the dirt picked up by oily surfaces.

The result is better film life and clearer pictures, and there can be no damage to optical elements in the sound reproducer below the projector mechanism. Longer life for each moving part will definitely result from the use of these pre-lubricated ball bearings, which are now regarded as the most modern and effective method of giving to machinery the characteristics of vastly improved wearing qualities, and smooth and silent operation.



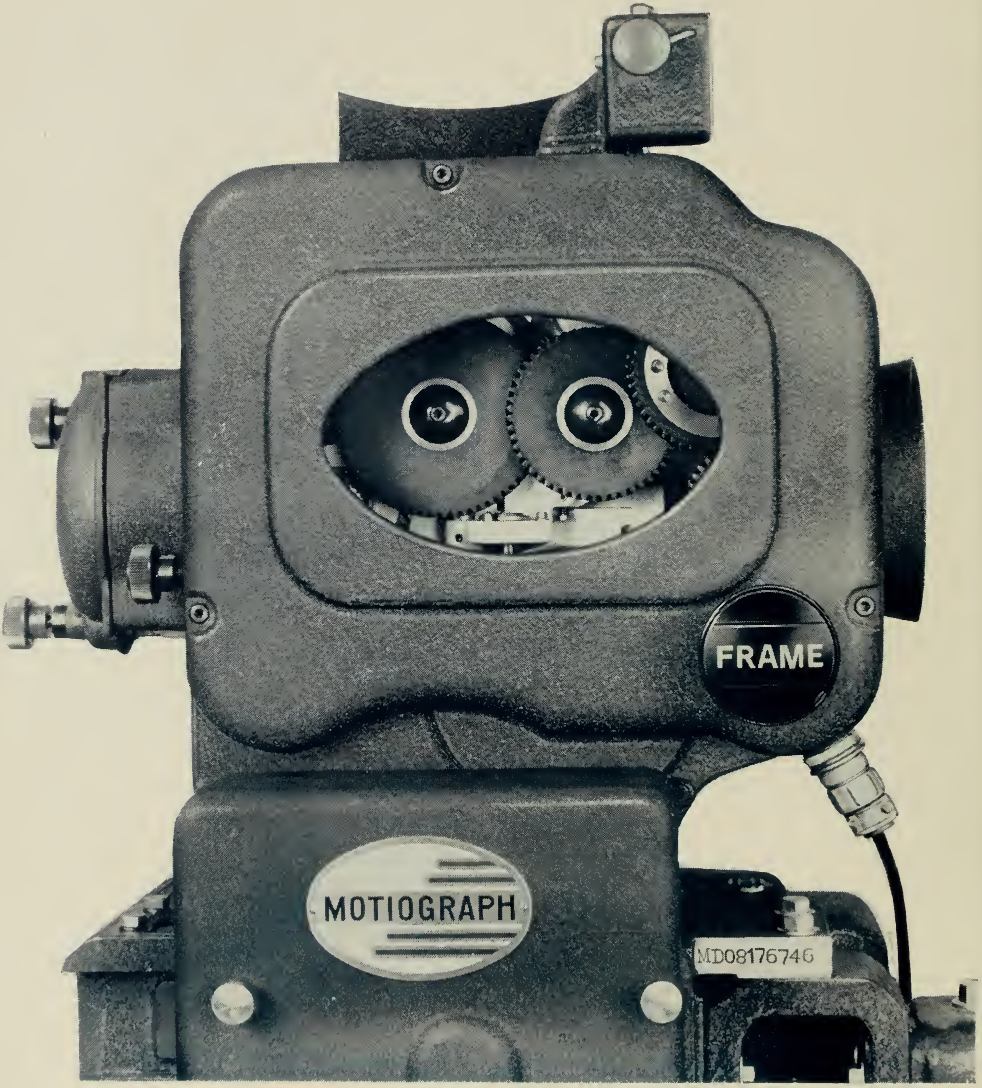
The Motiograph "AA" mechanism, with door removed from the operating side.

Wiring

The principles of modern engineering and

simplicity of operation and replacement which are characteristic of the Motiograph "AA" are well exemplified in the wiring of the mechanism. A number of features in this respect are to be found in no other projector.

If the necessity should arise for the replacement of the mechanism, the wiring to the framing light, mechanism light and the change over device is all contained in one plug. This plug can be pulled out of the receptacle connector, which is fastened to



The gear side of the Motiograph Model "AA."

the main frame of the mechanism. In this manner, the head may be removed without disconnecting any wires.

Ventilation

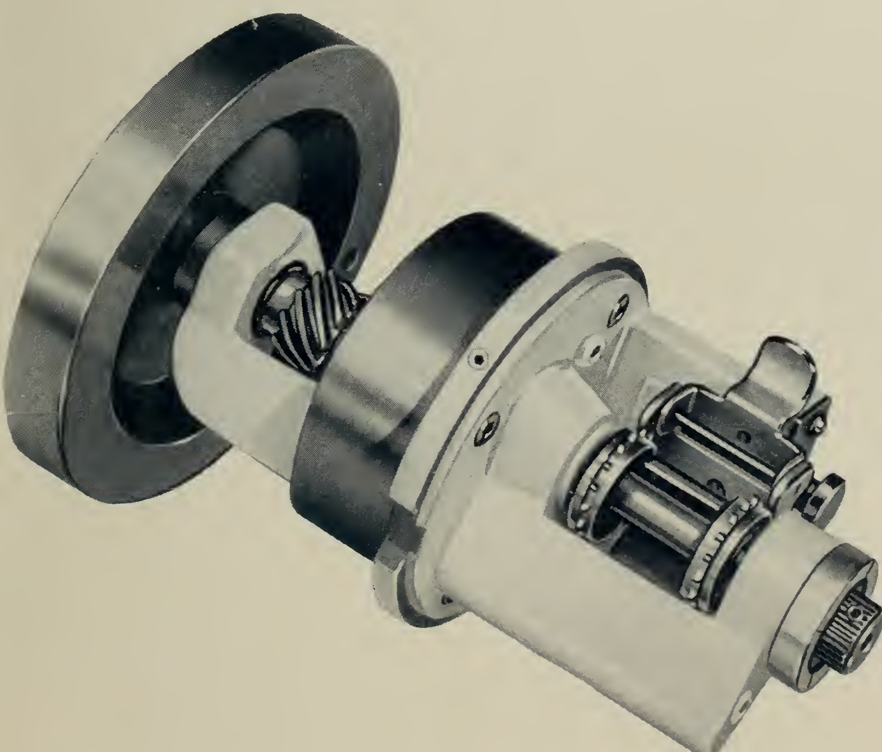
The ventilating system of the Model "AA" has aroused much favorable comment among projection experts. A one-piece cylindrical fan located near the top of the projector immediately above the picture aperture is associated with both the double shutter and fire shutter governor. This fan draws clean room temperature air up through the double shutter and across the aperture, and then discharges the warm air through an opening at the top of the mechanism.

Though the flow of air at the aperture is considerable, the air is not forced into or drawn out of the lamp house, and thus no carbon dust is drawn into the mechanism. Neither is there any necessity for a glass filter between the light source and shutter to prevent disturbance of the tail-flame of the arc.

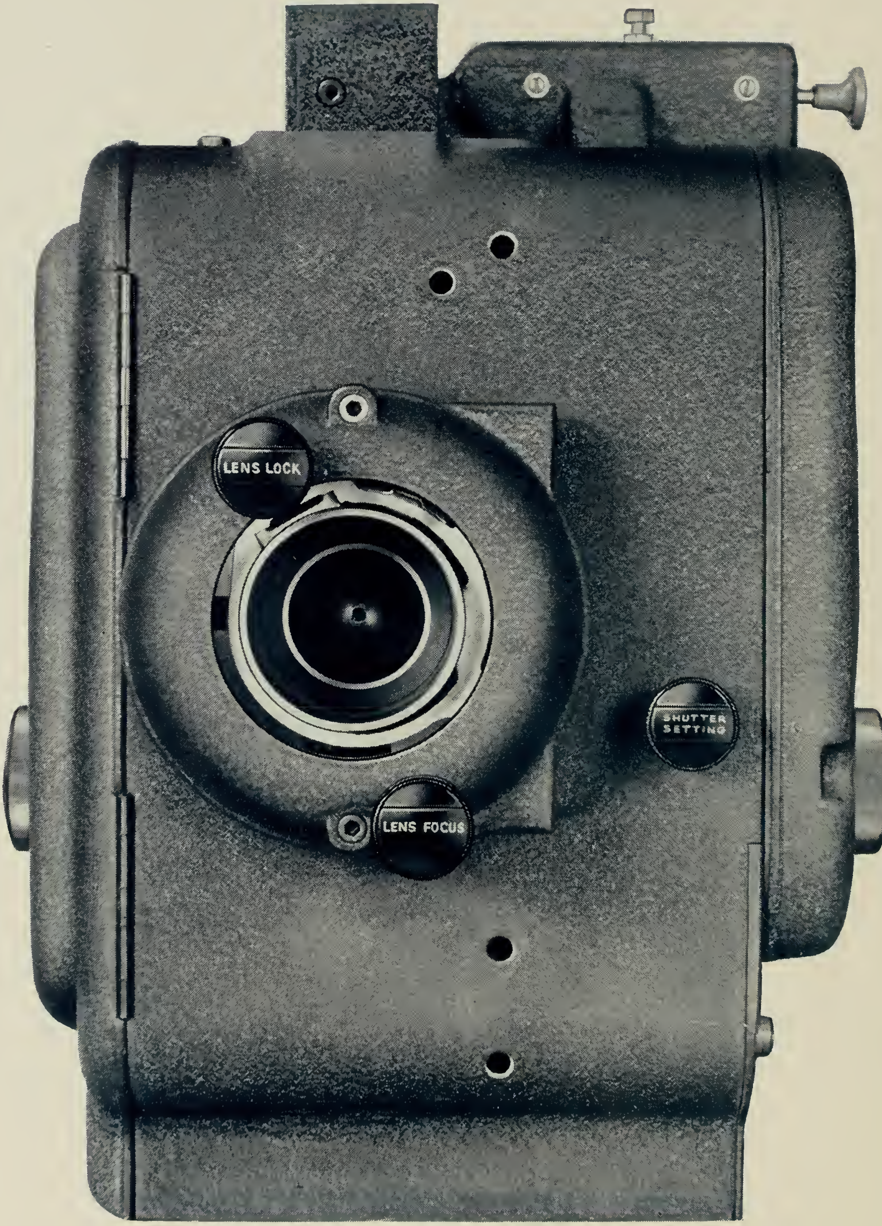
The Intermittent Movement

The hardened steel parts of the movement are ground to exacting tolerances, thus making possible its flawless functioning. Ball bearings, together with an adequate grease reservoir, assure perfect movement lubrication.

The movement may be quickly and easily removed from the operating side of the mechanism, and is just as readily replaced. The intermittent sprocket, which is firmly held in correct position on the star shaft by



Motiograph "AA" intermittent movement.



Front view of the Motiograph Model "AA" mechanism.

an entirely new method, can be reversed in a few minutes' time without removing the intermittent movement from the mechanism.

The Double Shutter

The Motiograph "AA" shutter gives maximum screen illumination and the utmost in picture definition without appreciable flicker or travel ghost. The shutter rotor has integral cooling fins which serve to circulate cool air over its bearings and over the picture aperture.

One of the most remarkable improvements of the Motiograph Model "AA" mechanism is the setting of the shutter in relation to the intermittent sprocket. This adjustment, while extremely simple, is both accurate and fast.

The double shutter is provided with a simply operated timing adjustment which permits fine timing corrections while the mechanism is in motion by merely turning a knob located on the front of the mechanism.

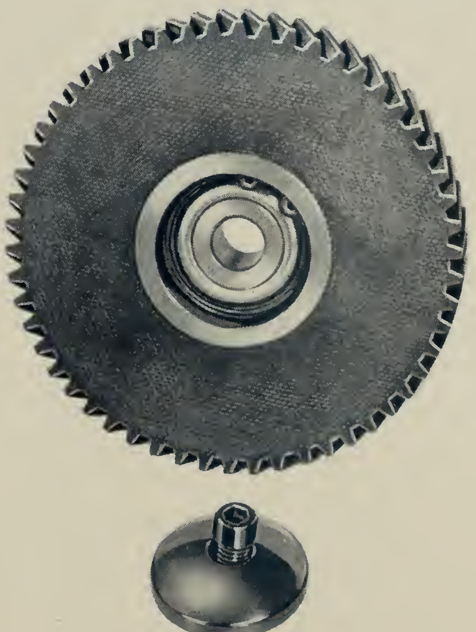
The double shutter, like all other moving parts, is entirely contained within the projector housing.

The Film Path

The film enters the projector from the upper magazine by way of a fire trap unit having four properly designed quenching rollers, with a long chute in between the rollers. It then passes around a hardened steel guide roller to the upper feed sprocket. This roller, along with the pad roller of the sprocket, steadies the motion of the film as it enters the mechanism. There is thus a complete absence of the tendency for the film to jerk and slap as it comes from the magazine—a fault common in mechanisms of older design.

From the upper feed sprocket the film loops upward and to the rear to enter the gate of the mechanism, through which it is pulled by the intermittent sprocket located directly below the gate, while held in compliance by a separate intermittent sprocket shoe. After leaving the intermittent sprocket, the film loops downward and again toward the rear, and then forward, passing over and around the lower feed sprocket. Double pad rollers on this sprocket securely hold the film in engagement and assist materially in smoothing out the pulsating film travel produced by the intermittent action. In this way the motion of the film is smooth and steady as it leaves the projector to enter the sound reproducer. This point is of importance, for the film motion stabilizing system of the sound reproducer thus does not have to cope with gross irregularities produced by the intermittent action. Better sound quality inevitably results.

The "AA" film gate opens forward to provide a full inch clearance between tracks and shoes. The gate is opened by a quarter turn of a large and conveniently placed



Bakelite gear, with ball race inserted, employed in the Motiograph "AA" mechanism.

operating knob and closes automatically by simply pressing inward on the same knob. The one inch clearance permits exceptionally easy cleaning of the aperture, tracks and tension shoes, and obviously makes threading an extremely simple operation.

The tracks and aperture are combined into one sturdily constructed unit of stainless steel, and this unit is easily removable from its support casting for routine inspection and cleaning. The film is guided over the tracks with a complete absence of sidesway by means of rugged, self-adjusting guide rollers located just above and just below the aperture opening. The guide rollers run on hardened pivot-type internally lubricated bearings. They are large in diameter, and are made of hardened steel to insure extremely long life.

The two long film tension shoes extend the full length of the film tracks, and for perfect alignment they are combined into one rigid unit. This unit is held to the gate assembly by a unique gunlock mechanism which permits easy removal for cleaning. The unit snaps back into its correct position at the touch of a finger, and there is no chance for misalignment or for disturbance of the tension adjustment.

The shoe tension device is likewise unique in design. It is controlled by a calibrated indicator lever having three settings—"low" for new, green film; "standard" for average condition film; and "high" for badly buckled older film. The setting can be changed with the projector in operation. The tension device is cam-operated.

To insure adequate and positive engagement of the film on the intermittent sprocket, a separate intermittent sprocket shoe is provided. This shoe holds the film in place over five sprocket teeth, and is self-aligning in design. The shoe proper is, of course, made of long wearing steel, and is carefully ground and polished. The shoe support mechanism opens by means of an easily accessible double finger grip, and closes by a light touch of the mechanism actuating button.

The simple direct film path, the easily operated pad roller brackets, the automatic closing devices on the gate and intermittent sprocket shoe mechanisms, and the liberal working room throughout the projector, all combine to make the "AA" easy and convenient to thread and operate. To further facilitate perfect threading and to make the operation simple, an illuminated framing aperture is provided at the top of the track support casting.

In forming the upper film loop, the film is placed, in frame, on locating pins on either side of this aperture. As the film is drawn downward over the tracks, it is automatically and exactly framed in the actual picture aperture below. Framing can be checked at any time prior to starting the machine by merely bending the upper film loop back over the framing aperture.

Perfect Optical Alignment

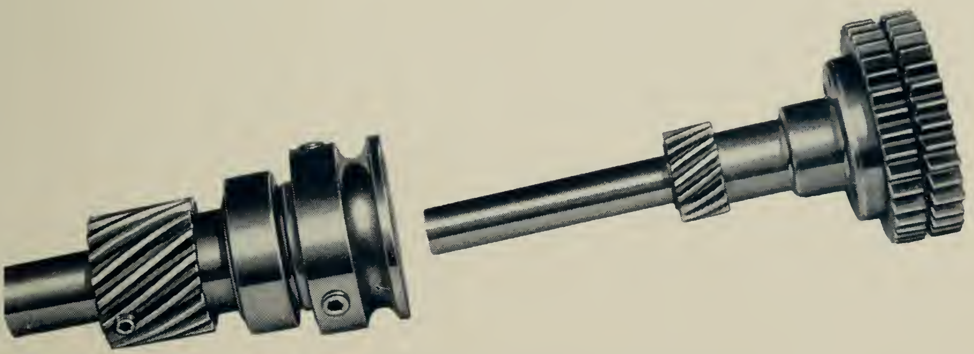
The track and aperture support casting, the tension shoe support casting, as well as the lens mount, are all attached to one casting fastened to the center frame, which gives perfect optical alignment at all times.

The lens mount accommodates any make or model and virtually any size of projection lens. The lens mount travels in two steel "V" rails. The upper rail is held rigidly in the one position that assures perfect alignment of the lens barrel with the picture aperture. The lower rail may be adjusted upward to take up any slight wear that might occur after many years of operation.

An entirely new type of locking device holds the lens in firm optical alignment. Another new device makes possible the removal of the lens for cleaning and subsequent replacement without the necessity for refocusing. The focusing control, which may be operated from either side of the projector, is smooth, precise, and positive in action. The entire lens barrel assembly, including the lens locking and focusing device, may be taken out of the mechanism as a unit by the removal of but two Allen screws.

Framing

Framing is accomplished by moving the intermittent movement carriage vertically on steel "V" rails firmly attached to an opening in the mechanism center frame. Large control handles are on either side of the mechanism. These are carried by a sturdy through-shaft, which also mounts a pinion to engage an associated rack on the movement carriage. This patented feature will always hold the intermittent movement firmly in the desired position, as no gear back-lash can develop.



Gear drive assembly unit of the Motiograph "AA."

On the operating side of the projector there is a dial indicator to show the exact position of the carriage with respect to the aperture. The projectionist can thus instantly set the carriage to its center position before commencing the threading operation, and can see the direction to turn the control in case of a misframe during a reel without shifting the frame line completely up and down the screen.

The framing action is rapid and positive. A one-third turn of the control knobs shifts the picture a complete frame. The entire framing device is so balanced and tensioned as to prevent framing drift, while still providing for very smooth and easy operation of the controls.

Since only the intermittent sprocket moves with respect to the picture aperture, there can be no disturbance of the film loop between the projector mechanism and the sound reproducer during framing, and no complex toggle gearing is required to prevent such disturbance.

Fire Shutter and Governor

The newly designed fire shutter governor in the "AA" mechanism is ruggedly and simply constructed to insure reliability in this important part of the mechanism. It operates at sufficient velocity to have adequate power to overcome all friction in the connection linkage, and to lift the exceptionally heavy fire shutter proper. Springs aid the closing action and help to provide for positive closing the instant the film speed falls to fifty-five feet per minute. The heavy shutter and its well-designed actuating mechanism thus make the "AA" an exceptionally safe machine to operate from the viewpoint of fire hazards.

A manual light lever for the fire shutter is provided near the upper part of the track support casting to facilitate screen light checks with the projector at rest.

Interchangeability

The "AA" is designed to be used with any modern sound reproducer and any make of upper magazine without changing the existent projector drive and without using mechanism plates or adapters of any kind.

The "AA" Base

The new base provides for precise horizontal and vertical optical alignment, as its lamp house carriage may be moved from side to side, while the sound reproducer support bracket may be easily raised or lowered. When securely locked in place, the utmost stability is achieved for the lamp, sound reproducer and mechanism. Leveling screws are provided to compensate for irregularities in the projection room floor, and the tilting device makes perfect projection possible regardless of the projection angle. The base is provided with an arc switch of the 100 ampere double-pole single-throw type, as well as a heavy duty motor starting switch, accessible from either side of the projector.

The "AA" Magazines

A full 18 inches in diameter, Motiograph "AA" magazines accommodate 2,000 foot reels with ample room for convenient loading and threading of the film. Both the bodies and the doors are of heavy construction, while the hinges are cast and are nickel plated. They are equipped with fire-trap rollers that are quickly demountable for cleaning. The magazines are wider than the conventional ones in order to accommodate bent reels without scraping the sides of the magazines. The upper magazine is provided with an adjustable reel shaft tension device, which prevents even the heaviest reel from overrunning and causing film breakage.

"I understand that you lived next door to her before she became a screen star."
"Yes. We were the same age then, but now I'm forty and she's twenty-six."

Modern Projector Design

Technical Data on the Model "AA"

In order that theatre owners, projectionists and motion picture engineers may have a good idea of the "AA," the present object is to present some of the technical details which go to make up this projector.

The underlying thought in regard to the "AA" was that it must be a mechanism of completely new design rather than simply a revision of earlier Motiograph projectors. The designers were thus unhampered by traditions and customs, except in the matter of mounting and drive arrangements, and were free to use improved materials, finishes and processes which were derived from war work, including Motiograph's own work in producing precision machined components and major assemblies for ordnance equipment.

The Projector Housing

To provide for accurate alignment of components and stability in operation, the housing of the Motiograph "AA" is a one-piece casting enclosing all the working parts of the mechanism. The large cast door, hinged at the front, provides access to the interior of the film compartment for threading, and its double windows permit the upper and lower film loops to be readily observed during operation. A tubular extension of the main frame casting supports the lens carriage with exceptional rigidity. The drive gear compartment on the drive side of the mechanism is equipped with a dustproof cast cover firmly held in place by Allen cap screws. This construction is made possible by the fact that little access to the drive side is required, and thus harmful dirt and grit are kept out of the working components of the machine.

Most of the working parts are supported by the reinforced center frame, which is an integral part of the housing casting. It stiffens the housing, and provides the rigid and stable supporting means for the film drive components and for the optical elements required for minimum machine vibration and maximum steadiness in the projected picture. The entire housing is quite large by former standards, being 15 inches high, 11 inches deep and 18 inches long. The weight is not cumbersome, however, for all of the major castings are made of light but strong aluminum alloy. The housing corners are rounded and its contours are smooth. The general appearance conforms to accepted concepts of modern streamlined design while preserving functional efficiency.

Construction of Mechanism

The Motiograph "AA" projector is of unit construction, with all major components easily removable for inspection, cleaning or servicing without the necessity for disassembling the machine. In the drive gear-

ing, this has been accomplished by the virtual elimination of long shafts carrying numerous gears. Power is transmitted to the various film drive points by hardened steel gears meshing smoothly into laminated bakelite gears. The gears run on grease-packed double-row ball bearings which are rigidly supported by studs locked into the mechanism center frame. The gear meshes require no lubrication other than an original film of lubricant as long as they are kept clean, for experience indicates that gear wear results primarily from the lapping action caused by dirt and grit brought in by frequent hand oiling or by poorly filtered lubrication systems of the continuous or distributed type.

This is brought out in the diagram of a typical gear assembly (Fig. 1). Item 6 is the supporting stud which is locked in place in the center frame by the screw, Item 4. Item 7 is the double-row, sealed ball bearing which supports the Item 5 gear assembly. These bearings are the lubricated-for-life type, and almost indefinite wear may be expected. The bearings are held in place on the gear hubs by snap rings, Item 1. The gear and bearing assemblies are locked securely to their mounting studs by the reinforced decorative dust caps, Item 3, and the Allen cap screws, Item 2.

Figure 2 shows the simple and rugged gear train of the "AA" Projector. Power from the drive shaft at the bottom of the mechanism is transmitted by gear combinations to the ball bearing supported vertical shaft just back of the intermittent movement flywheel. This shaft passes through and is keyed to a wide, movable pinion which meshes with the drive pinion on the intermittent movement cam shaft, thus permitting the movement to be shifted vertically for picture framing. Furthermore, the position of the wide pinion with respect to its mating pinion on the movement is adjustable to provide a continuously variable shutter timing control which may be operated with the projector running. Since

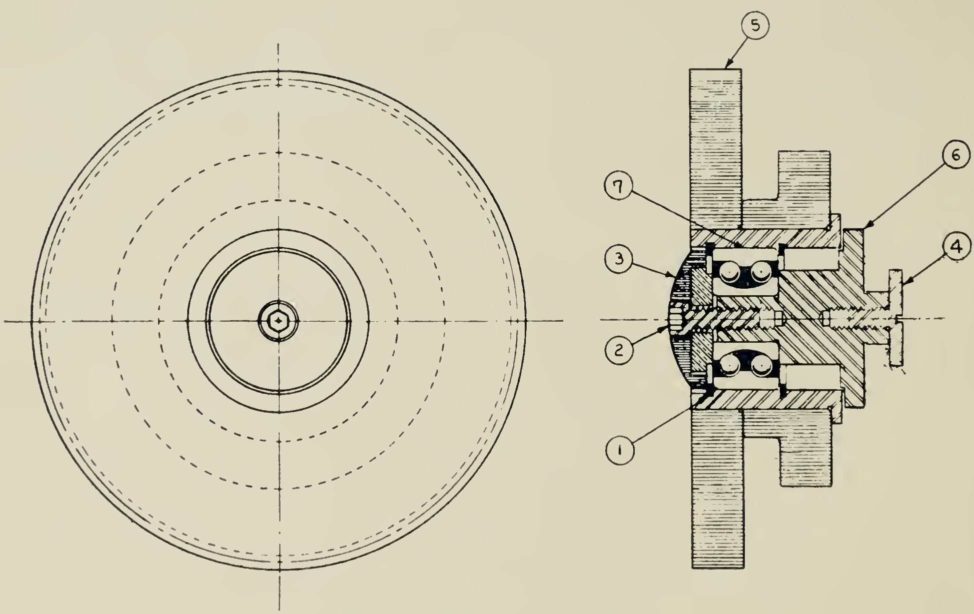


Fig. 1. Typical gear assembly.

this control moves with the intermittent carriage, it is extended to the front of the mechanism housing by means of a flexible shaft.

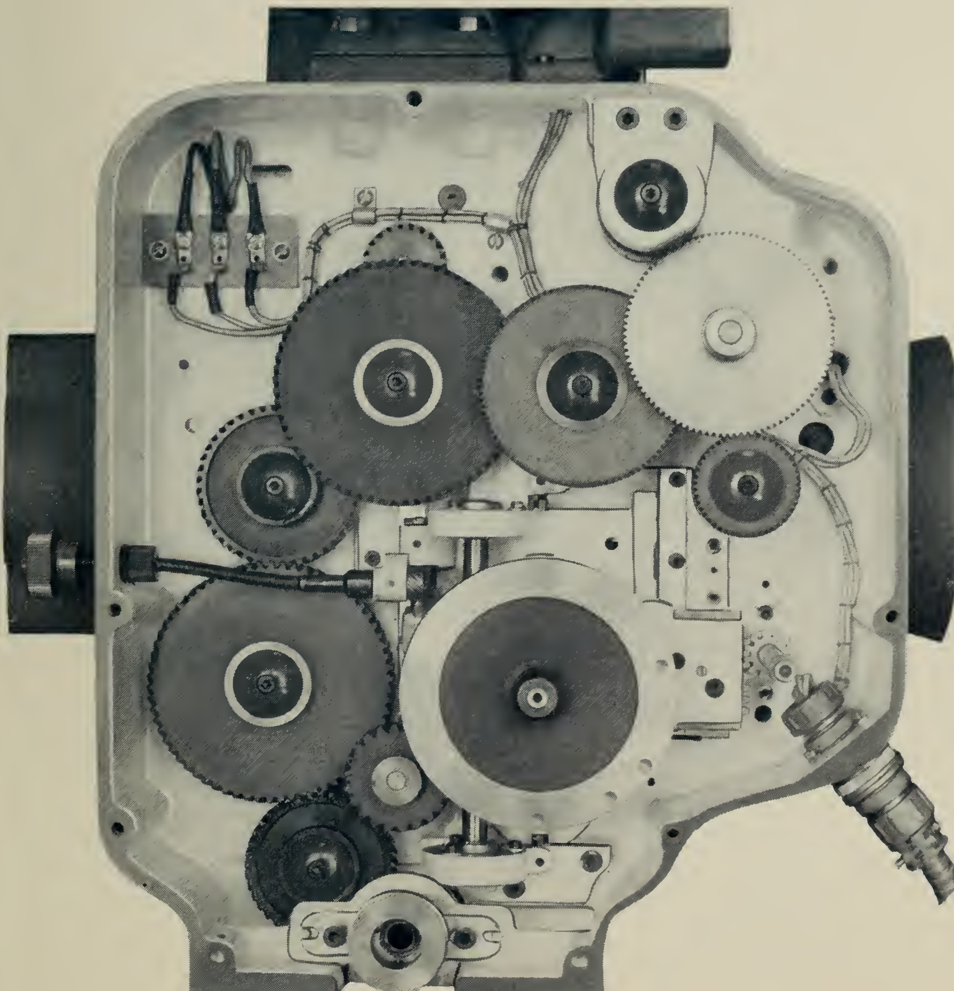


Fig. 2. Motiograph "AA" projector mechanism, drive side, cover removed.

Both the upper and lower feed sprockets of the projector are driven by stub shafts carrying on their drive ends suitable gears to mesh into the main gear train at the required points. The lower such shaft is just above the main drive shaft, and it also carries the drive gear for the vertical shaft. The gear on the upper is above the upper large bakelite idler gear. This idler and those to the right of it transmit power to the shafts carrying the shutter rotors and to the shaft of the blower and fire shutter actuator.

The main drive of the "AA" projector is made in the form of a socket shaft into

which the soundhead drive unit may be clamped in order to eliminate the need for oiling of the sound reproducer's projector drive assembly, and to provide a more rugged construction at this critical point. and since the drive shaft requires no additional lubrication during the long life of its sealed ball bearings, the risk of damage to soundhead optical components from excessive oiling and oil leakage is eliminated.

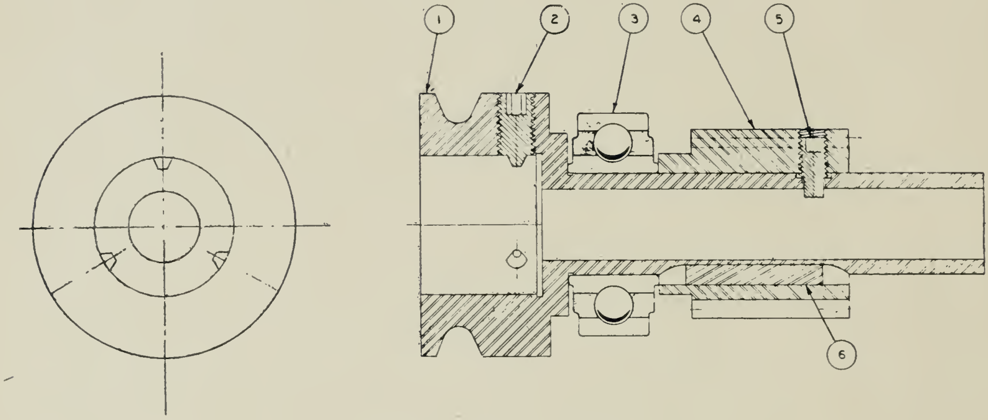


Fig. 3. Drive Shaft.

Referring to diagram Figure 3, the tubular shaft and socket unit, Item 1, runs in the sealed ball bearing, Item 3, and in a similar bearing set into the center frame of the mechanism. The Item 3 bearing is seated in an auxiliary rib of the main housing by easily operated clamps, so that the entire drive unit may be quickly and simply removed or replaced in operating position. The soundhead's drive unit is locked into the socket shaft by the set screws, Items 2 and 5, and the heavy-duty pinion, Item 4, is fixed on the tubular shaft by the Item 6 key. The large end of the shaft is provided with a belt groove for driving lower magazine takeups when the projector is operated with certain older sound reproducers having no take-up drive facilities of their own. This drive construction eliminates the possibility of damage to projector gears due to poor alignment between the projector and soundhead. There are no long sleeve bearings to bind from inadequate lubrication,

The Film Path

The exceptional roominess of the "AA" provides for threading simplicity. The film enters the projector from the upper magazine through a fire trap unit having four quenching rollers running on grease lubricated pivot bearings. Between both upper and lower rollers there is a long chute to aid in the quenching action. From the fire trap the film passes to the upper feed sprocket, upon which it is held in place by the combined action of the sprocket's pad roller and the hardened steel guide roller just above and to the right of the sprocket. The film is thus guided smoothly over the sprocket, which engages six full perforations, and there is thus no tendency for it to jerk or slap because of uneven hold-back tension from the magazine. This increases film life over that from the conventional four tooth engagement.

The film loops upward from the upper feed sprocket and then passes down through

the gate to the intermittent sprocket, around which it passes in a clockwise direction to form the lower film loop. For best alignment and for proper engagement of the sprocket and film, the tension shoe assembly is made part of the intermittent unit itself. The leaving end of the lower film loop passes over the lower feed sprocket clockwise and the film then travels downward to the sound reproducer. Double pad rollers on this sprocket insure sufficient engagement between sprocket teeth and film perfora-

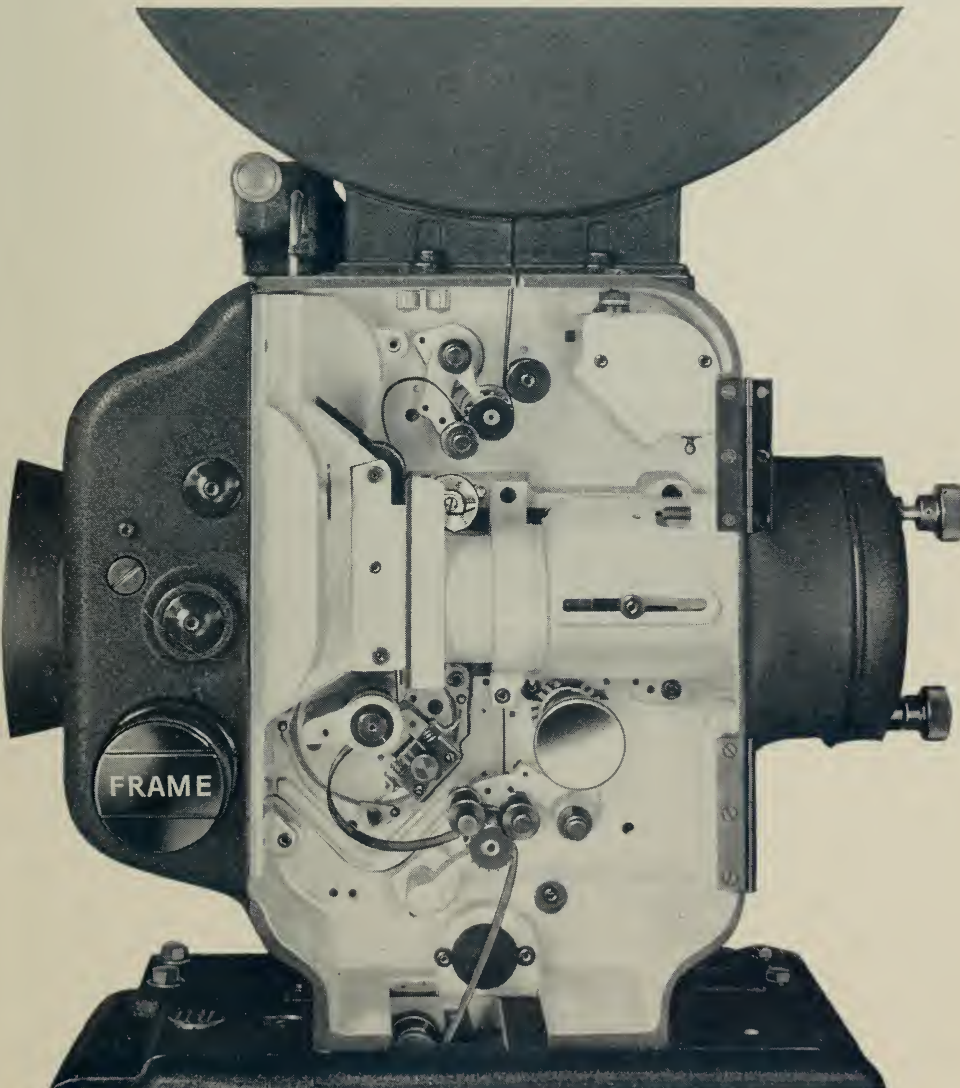


Fig. 4. Operating side showing film path; door removed.

tions to block the pulsating film travel produced by the intermittent movement. The film is fed smoothly to the reproducer and the film motion stabilizing system thus does not have to cope with the irregularities produced by the intermittent action. Better reproduced sound quality inevitably results.

A distinguishing feature is that the film path below and to the right of the lower feed sprocket is completely clear of all obstructions, with the exception of the cast stripper for this sprocket. This allows plenty of space in this region for the possible eventual addition of such auxiliary equipment as double film attachments and control track pickup facilities. For the former, the stripper mounting boss is so located and designed as to permit the substitution of another double pad roller assembly for the stripper, so the bottom of the feed sprocket may be used to feed the separate sound track film to the sound reproducer, with the picture film going across the top of the sprocket and thence by an external chute

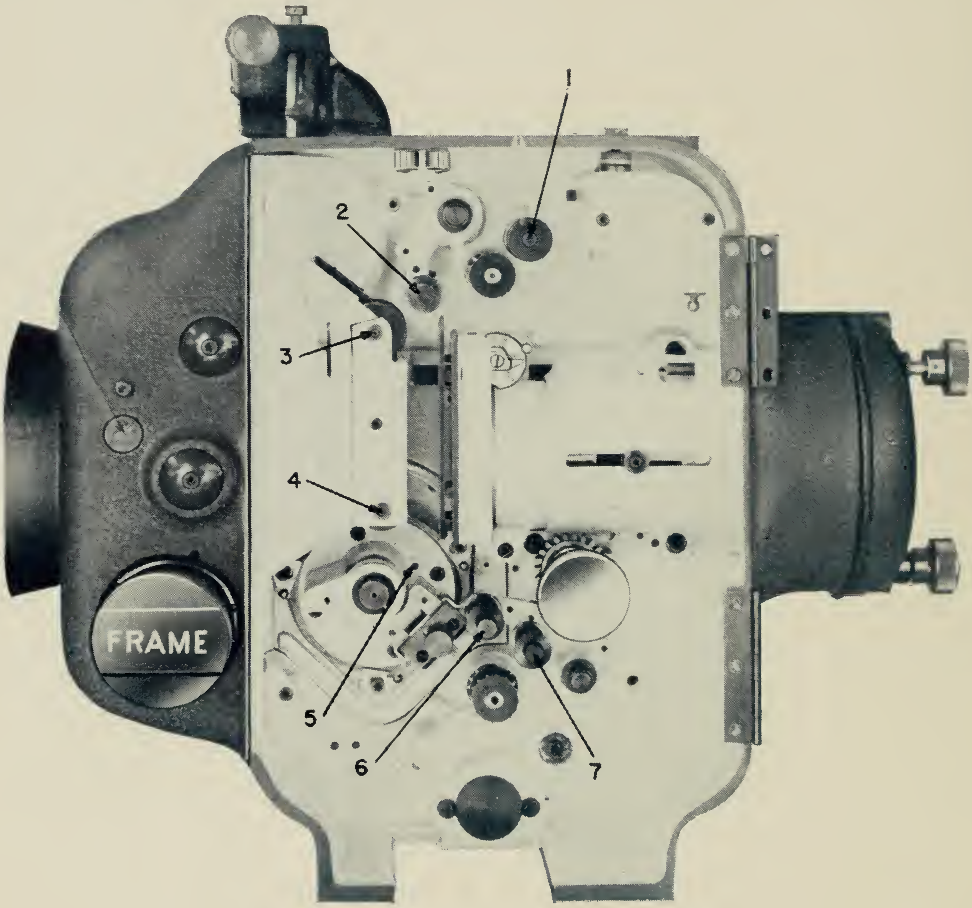


Fig. 5. Operating side, film gate open.

to the picture film takeup magazine. There is likewise adequate clearance below the feed sprocket to accommodate the feed and guide rollers of a new double film type of sound reproducer requiring no external chute and no projector modifications.

The Film Gate

It will be noted that the film gate (see Figure 5) of the "AA" when opened forward, provides a full inch clearance between tracks and tension shoes, thus allowing really adequate finger room for threading and for routine cleaning of aperture, tracks, shoes and guide rollers. The two long film tension shoes extend the full length of the film tracks, and for perfect alignment they are combined into a single rigid unit of hardened steel. The film contacting surfaces are ground and polished. This unit is held to the gate assembly by studs at the top and bottom which engage a unique gunlock mechanism within the gate body. The studs snap into operating position as they enter their locating slots in the gate body face. They are instantly released by pulling out a small plunger near the top of the gate body. The shoe unit is therefore removable for routine cleaning almost as easily as the film itself, and there is no chance for disturbance of either the alignment or of the tension adjustment.

Operation of the film gate is by a rack and pinion type control device just below the lens barrel. A quarter turn of its large control knob opens the gate, and another version of the gunlock mechanism within the control shaft automatically locks the gate open as the knob is released. The gate closes and locks closed by simply pressing inward on this same knob to release the first locking device.

The diagrammatic view of the gate assembly (Figure 6) shows additional details. Item 1 is the base casting. This casting has an extension at the left to support the track and aperture unit, Item 2, while the gate body moves in long V-rails on the steel balls indicated as Item 5. These same V-rails also support and guide the lens carriage. It is obvious, therefore, that all components concerned in the relationship between the film

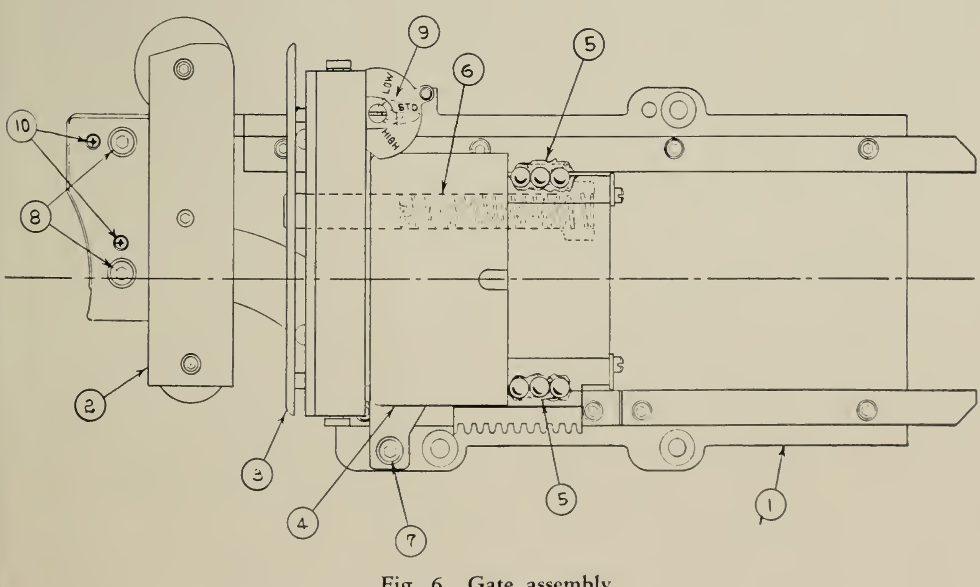


Fig. 6. Gate assembly.

plane and the lens optical axis are part of a single major assembly which may be aligned with the utmost precision.

The spring, Item 6, automatically closes the gate when the operating control catch is released. Item 4 is a fixed light guard casting which covers the end of the projection lens nearest the film plane to prevent stray light leakage at this location. Item 3 is the tension shoe unit proper. Shoe tension is applied by the semi-circular projections visible between the shoe runners and the gate body. These are at the ends of two transverse pressure bars within the body. Variable pressure is applied to the centers of these bars by flat springs on a vertical shaft whose mounting screws are visible at the top and bottom of the gate body. The degree of tension is determined by the cam-type tension control, Item 9. The pressure applied to the shoe unit in the "standard" position of this control is approximately 350 grams, and this value is satisfactory when films in average commercial condition are being run. The "low" position of the control reduces the pressure to about 225 grams to accommodate new, green film, and the "high" position increases the tension to around 675 grams to aid in flattening badly buckled older films. The control setting may be changed with the projector in operation.

Film Tracks and Aperture

The diagram of the track assembly (Figure 7), shows how the track support casting is fastened to the base of the gate and

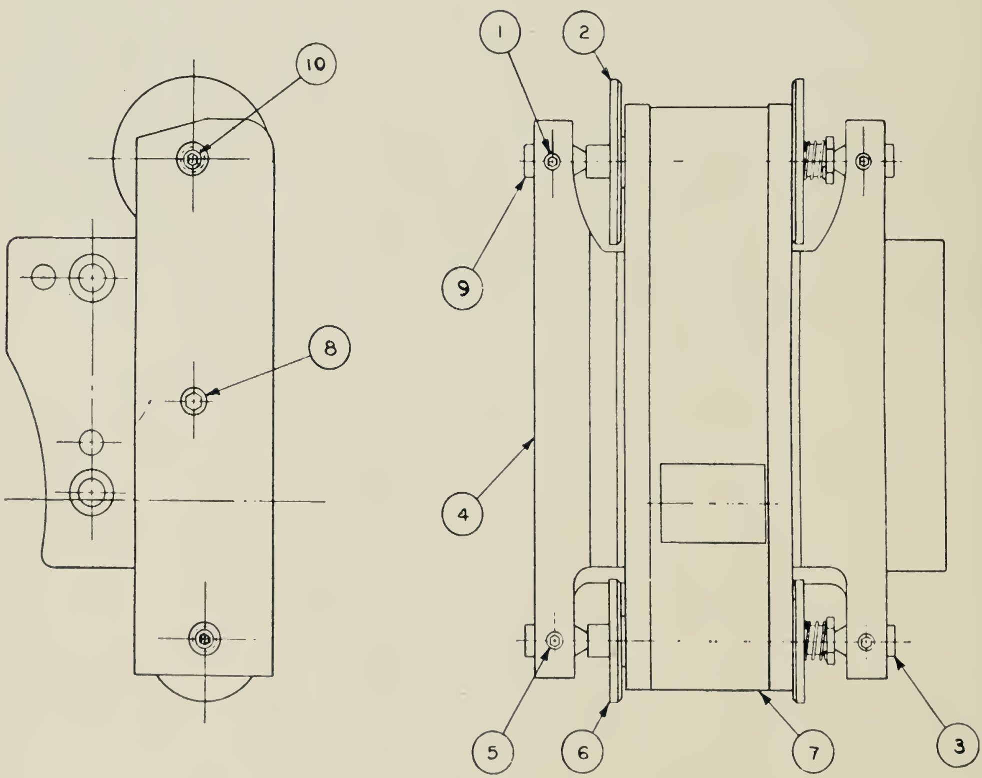


Fig. 7. Track assembly.

lens carriage unit. After accurate alignment with the optical axis is made, the casting is dowelled in place on the base so that it may be taken off and replaced without disturbing the alignment. The track and aperture unit is very accurately machined and can be replaced after long use with full assurance that the optical alignment will not be impaired.

roller assemblies, Items 2 and 6. Each has a fixed flange, or roller half, for the sound track side of the film and a movable flange under small spring tension for the opposite side, to accommodate films having various degrees of shrinkage without producing film buckling or failure of the guiding action. The roller assemblies are relatively close to the aperture opening and are much

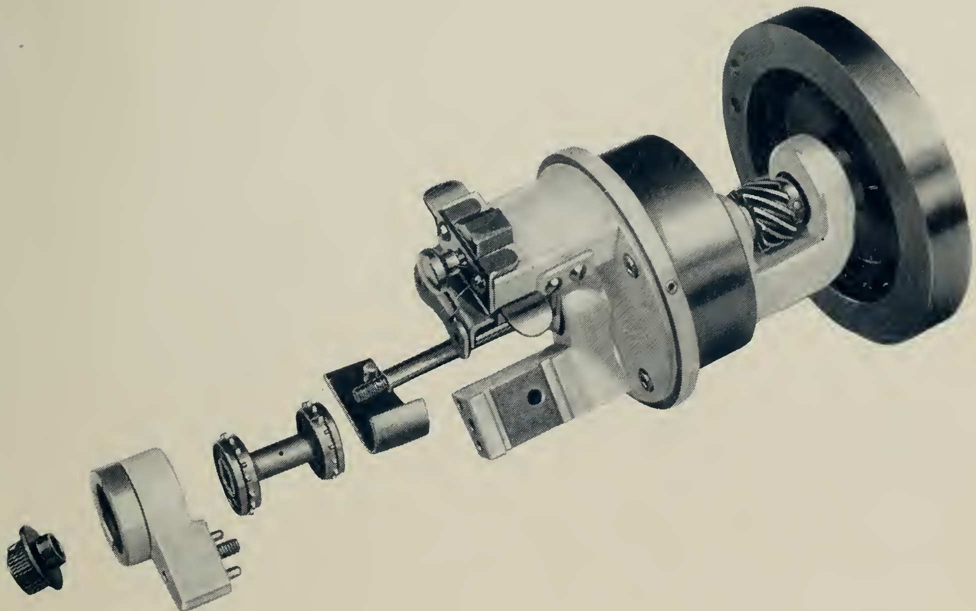


Fig. 8. The intermittent movement of the Motiograph "AA" disassembled to show cap, bracket, sprocket, stripper plate and housing.

The tracks and aperture of the "AA" are combined into one sturdily constructed unit of hardened and ground steel. This unit is Item 7. It is drawn securely against the support casting, Item 4, by the engagement between an anchoring stud on its rear surface and a long cone-point, socket head set screw, Item 8. The unit is thus very easily removable for inspection and cleaning without disturbing other projector components.

The lateral guiding of the film over the tracks is accomplished by the two guide

more effective in eliminating film sidesway than non-rotating, fixed types of lateral guides. The rollers are large in diameter so as to derive sufficient turning torque from the moving film, and are fabricated from very tough and thoroughly hardened steel alloy to resist wear. They turn freely on hardened pivot-type bearings lubricated internally through small openings in the tips from grease reservoirs within the bodies of the bearings.

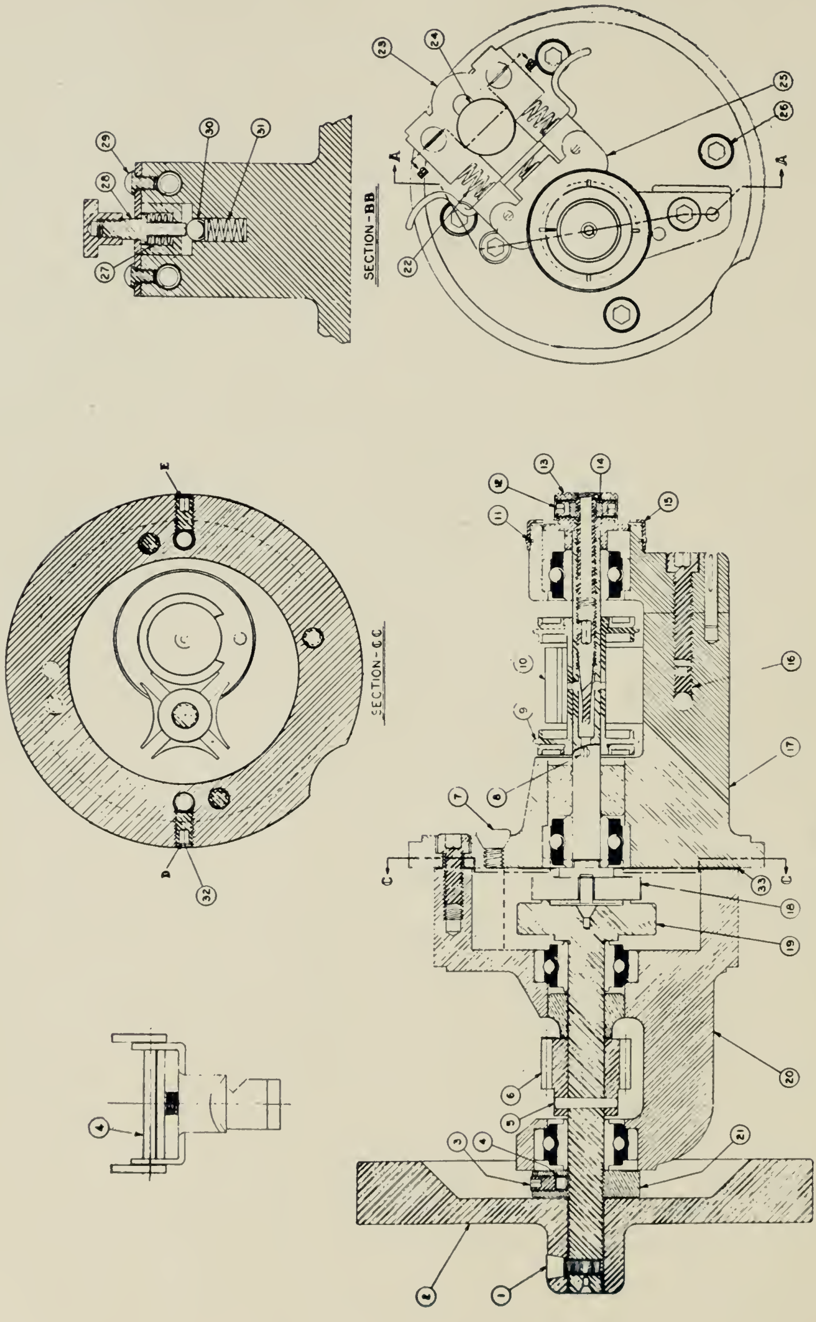


Fig. 9. Intermittent movement, sectional diagrams

The Intermittent Movement

The intermittent movement (Figure 8) has well been called the heart of the projector mechanism. While the movement of the Model "AA" is basically of the conventional 90 degree Geneva type, it nevertheless incorporates numerous original design features.

The tension shoe assembly for holding the film in place on the sprocket is mounted directly on the movement case. Outboard ball bearings for both the sprocket, or star shaft, and for the cam shaft are provided. The movement case design and the mounting arrangements in the projector are such as to permit the entire movement to be quickly and easily removed from the operating side of the machine without disturbing any other components except the movement balance wheel. The cam shaft is directly driven from the main projector gear train, and carries on its outboard end a balance wheel of sufficient diameter and weight to have adequate inertia to effectively equalize the pulsating torque requirements of the intermittent action.

The various sectional diagrams in Figure 9 show the intermittent movement and its components. Item 2 in Section AA is the balance wheel, locked firmly to the cam shaft by the cone-head, socket-type set screw, Item 1. Next in line from left to right is the cam shaft collar, Item 21. This is threaded to the shaft and can be locked in any particular position by the set screw and plug, Items 3 and 4. It provides means for loading the ball bearings to the exact degree necessary to remove all end and radial play while still permitting the shaft to turn freely with no danger of binding or freezing.

Shown next in Section AA is the heavy-duty drive pinion, Item 6, followed by a soft metal grease seal and the inner bearing. The two major movement housing castings, Items 20 and 17, are held firmly together, with the Item 33 gasket between, by the four socket head cap screws, Item 26 (Section A). Holes for these screws in Item 17 are somewhat larger than the screw diameters, and Item 17 is movably pinned to Item 20 at a point just to the right of the upper screw hole shown in Section CC. The two set screws, D and E, set into the rim of Item 17, bear against pins fixed in Item 20 and extending into clearance holes in Item 17. It is thus possible accurately to adjust the clearance between the cam ring and star radius surfaces by means of the screws D and E after slightly loosening the main fastening screws, Item 26. The cam and star run in semi-fluid grease inserted through the filler plug, Item 7, to the level of the dashed line in Section AA.

The star shaft bearing and grease seal construction is similar to that of the cam shaft, with Item 13 being the threaded, locking collar to take up end and radial play in the bearings. A movable indicator cap, Item 15, is provided with engraved lines spaced 90 degrees. In conjunction with a single line on the locking collar, it may be set to provide a ready indication of the points where the cam drive pin just starts to engage a star slot, thus facilitating shutter timing.

Unique in the "AA" movement is the method used for anchoring the sprocket to the star shaft. The shaft is hollow as far back as the sprocket, and is provided with a threaded, tapered screw engaging two steel balls which it pushes outward through holes in the shaft wall to lock into matching, but smaller, holes in the sprocket body sleeve. Lateral and angular positioning of the sprocket on the shaft is provided, however, by the aligning stud, Item 8, which engages an accurately machined slot in the sprocket body. The tapered screw cannot be backed out far enough to drop the balls from their sockets because of the presence of the tubular threaded insert in the star shaft which mounts the Item 13 locking collar.

For very rapid removal of the sprocket for inspection, cleaning, reversal or replacement, it is merely necessary to back out the tapered screw, remove the locking collar, take off the outboard bearing, by removing the single fastening screw which

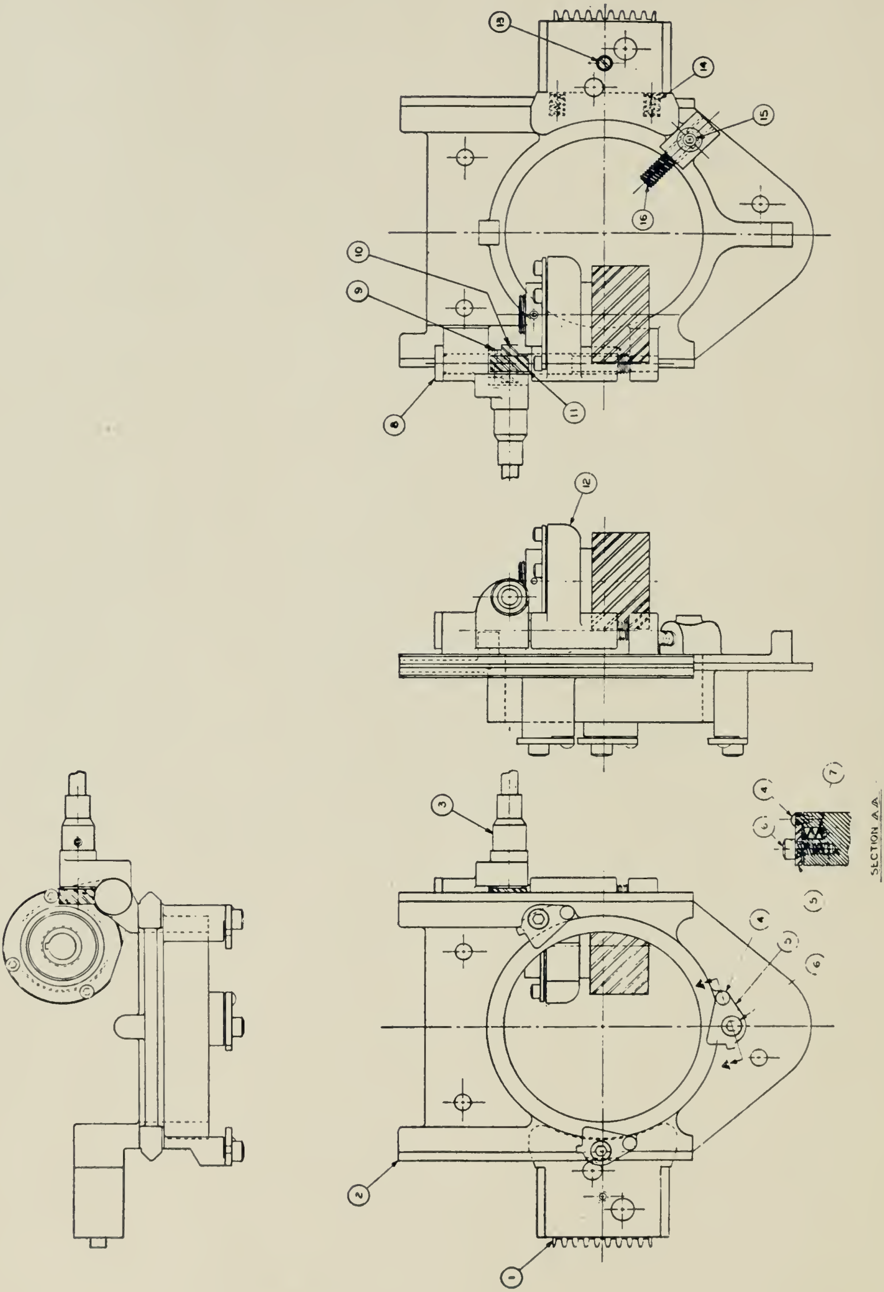


Fig. 10. Inner shifting frame

holds it on its locating dowels, release the stripper anchoring set screw, Item 16, at the bottom of the same hole, and slip out the stripper to release the sprocket. The whole operation can be performed in less than two minutes and since there is no need for removing the movement from the projector, there is no chance for disturbing the shutter timing.

The end view and Section BB, indicate the construction of the tension shoe assembly. Item 25 is the shoe proper, fabricated from tough alloy steel and thoroughly hardened, ground and polished. It is tensioned by a single center spring and is thus self-aligning and self-equalizing with respect to pressure on its two runners. Referring to the detail at the upper left, the shoe is held to its support plunger by the guide bars, Item 4. This view also shows the notch in the plunger visible as the blank white area just above the Item 30 latch ball in Section BB. The plunger is tensioned by the Item 22 springs. The tension shoe assembly is opened by pushing the finger grips away from the sprocket until the latch ball is pushed into the plunger groove by the Item 31 spring. It is released, and automatically closes by pressing the release button, Item 28, which pushes the latch ball out of the groove and allows the plunger to return to its closed position.

Framing

The diagramatic view (Figure 10) shows how the inner shifting frame which mounts the intermittent movement is moved vertically in V-rails for picture framing. The movement is held in place by the clamps, Item 5, and these are tensioned so that they will stay in their open positions by the springs, Item 7, visible in Section AA. The adjustable stop, Item 16, bearing against the movement rear bearing bracket permits the movement to be rotated in its seat to produce the proper mesh between its drive pinion and the wide pinion which is keyed to the vertical shaft. The wide pinion is mounted on the movable bracket, Item 12, which in turn is supported by the threaded shaft, Item 8. The flexible shaft, Item 3, from the shutter timing control via the small right angle gears, Items 10 and 11, turns the threaded shaft to move the wide pinion upward or downward and thus vary the angular relationship between the movement action and the shutter operation for fine shutter timing. The rack by which the shifting frame is moved for picture framing is Item 1. It is tensioned outward in its guides by the springs, Item 14, to take up all backlash between it and its associated pinion mounted on the through shaft carrying the large framing control knobs on either side of the projector housing. The tension springs obviously also exert braking pressures between the shifting frame and the left V-rail so as to prevent any tendency for the frame to creep in either direction, while still allowing for easy operation of the framing control. The control on the operating side is provided with an indicator dial to enable the projectionist to set the framing adjustment in the middle of its one and a quarter frame range before threading. This dial also permits him to see instantly in which direction to turn the control to correct mis-frames during operation without shifting the picture all the way up and down the screen.

Diagram 11, the shifting frame assembly, shows the hardened steel V-rails, Item 2, in place. The center top sectional view shows the relationship between the rails, the inner shifting frame, and the outer supporting frame which is solidly mounted to the center frame of the projector housing. As is evident from the plan view at the lower right, the left rail is fixed in position by the tightly fitting screws, Item 4. The right rail is likewise rigidly anchored by the screws, Item 6, which loosely fit the rail holes, thus allowing this rail to be moved to the left by means of the adjusting and lock screws, Items 1 and 7, to compensate for eventual rail wear.

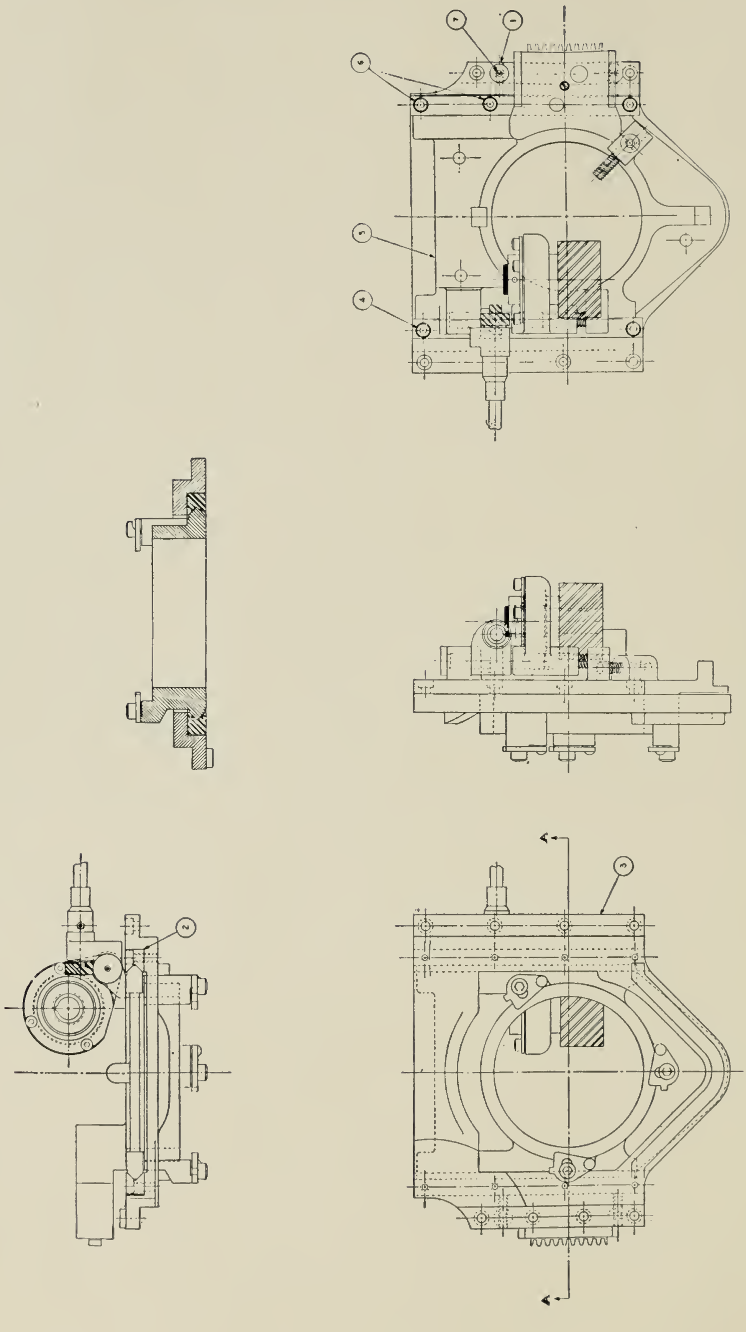


Fig. 11. Shifting frame assembly

Fire Shutter and Ventilating System

Centrifugal actuators for fire shutters should turn at relatively high speeds for positive operation without excessive dimensions. The "AA" projector design combines the fire shutter actuator with a blower of really adequate capacity to properly cool the shutter and aperture. The combination blower and actuator is located in an enclosure above the shutter compartment of the projector. It draws clean room temperature air inward through vents in the projector housing under the shutter, under the track and aperture unit, and upward over the shutter and across the aperture. The heated air is exhausted through a vent grill at the top of the mechanism. The shutter and aperture are thus located within a force draft "chute" with the light opening being closed off as far as air currents are concerned by the currents produced by the rotating shutter. Although the flow of air in the chute is considerable, the air is not forced into or drawn out of the arc lamp, and thus no harmful carbon dust and arc vapors are drawn into the projector. Neither is there any necessity for a light-losing glass filter between the shutter and light source to prevent disturbance of the arc tail-flame.

The details of the combination blower and fire shutter actuator are shown in the diagram, Figure 12. Item 1 is the cylindrical impeller. Item 2 is the support bracket for the spring tensioned, weighted arms of the centrifugal fire shutter actuator which operates the shutter proper at a film speed of 55 feet per minute through a system of levers. The supporting shaft for the unit runs in two ball bearings, one in the blower housing and one in an auxiliary bracket beyond the shaft's drive gear, which meshes into the main projector gear train. Other constructional details are self-evident.

Lens Carriage

The lens carriage is designed to accommodate any make or model and virtually any focal length projection lens by using suitable cylindrical adapter sleeves. It includes several design features to facilitate accurate focusing and easy removal of the lens for inspection and cleaning.

Referring to the diagram, Figure 13, the fixed portion of the carriage is Item 4. It is rigidly attached by socket head cap screws to the tubular front extension of the main projector casting. The movable portion is the lens barrel proper, Item 5, which slides in the hardened steel V-rails of the gate assembly and is moved by the focusing control,

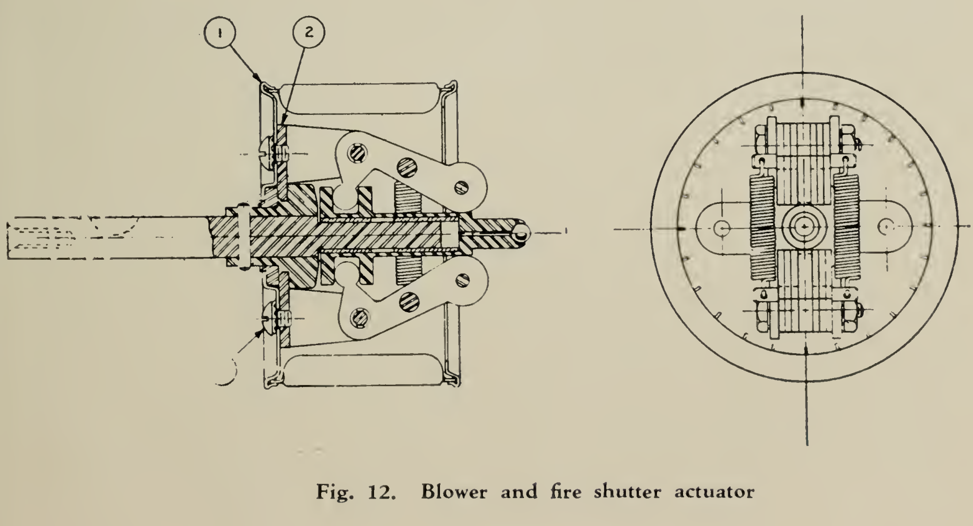


Fig. 12. Blower and fire shutter actuator

Item 10, which is provided with a finely threaded shaft, Item 16, engaging an extension lug on its under side. Backlash in the control is permanently prevented by the spring tensioned soft slug, Item 15, bearing on the threads.

which contact the guide slot in the barrel, and therefore, as it is drawn forward by the lock control, moves inward to clamp the lens rigidly in place. It cannot throw the lens out of alignment with the barrel, since it is the third member of a three point sup-

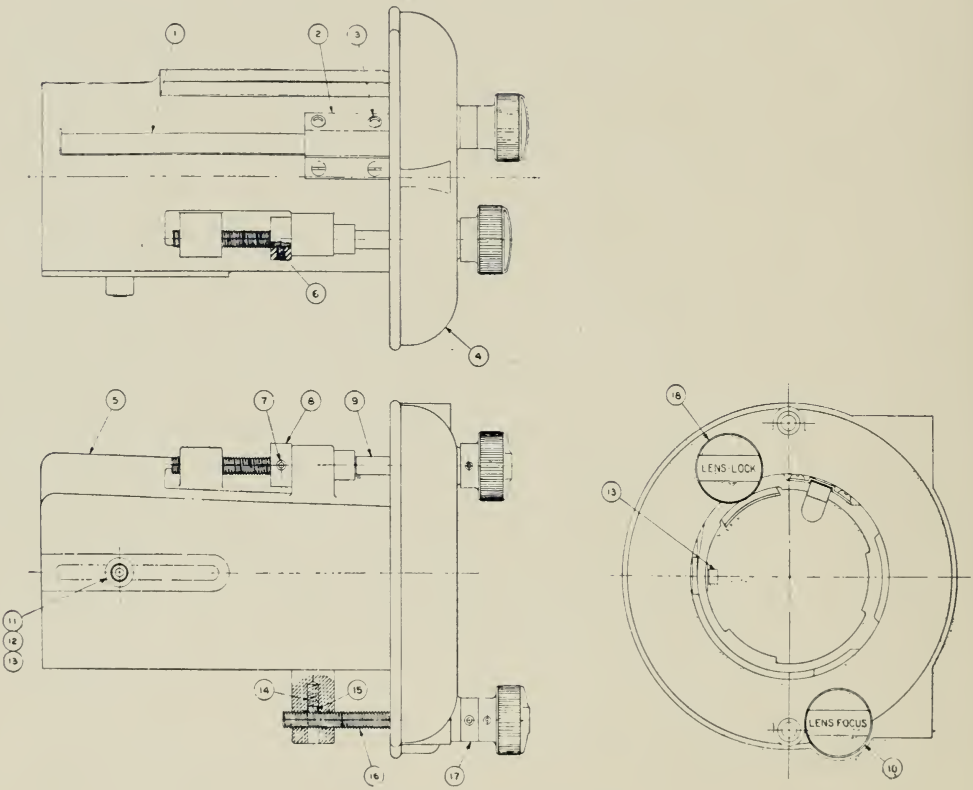


Fig. 13. Lens carriage

The lens is supported within the barrel by three accurately machined full-length pads. Two of these are solid projections from the barrel casting—the ones nearest the lens lock control being a separate, machined casting having a lug on its rear surface which extends through a slot in the barrel casting to engage the threaded shaft, Item 9, of the lock control, Item 18. This pad, or clamp, has a slight taper on the surfaces port system where the alignment is determined by the other two fixed members.

Items 11, 12, and 13 constitute an adjustable stop for longitudinal positioning of the lens within the barrel, and Items 1, 2 and 3 make up an extractor unit for shorter lenses. Projection lenses are thus easily removable for cleaning, and may be removed and replaced without disturbance to the focus setting.

Sprocket Pad Rollers

The same general design is followed in both pad roller bracket assemblies of the "AA" projector. In the diagram, Figure 14, showing the double pad roller assembly for the lower feed sprocket, the bracket swings on the shaft, Item 1, which is locked into a boss on the projector center frame. The shaft is provided with a grease recess, and carries on its outer end a knurled finger rest, Item 4. It is also provided with a notched cam section fitting into a recess in the bracket hub. One long straight notch, in conjunction with the stud pointed stop screw, Item 3, and locking screw, Item 5, limits the total travel of the bracket. Two V notches in conjunction with the steel ball, Item 6, and spring, Item 7, tension the bracket in its open and closed positions. The adjustable stop, Item 10, bearing against the center frame boss for the sprocket shaft, regulates the clearance between the outer roller and the sprocket. The inner roller's shaft has an eccentric mounting stud, thus permitting the clearance between this roller and the sprocket to be independently adjusted. Both roller shafts are hollow and have small holes under the rollers to communicate with grease reservoirs in the rollers. Semi-annual greasing through the shafts is sufficient to insure adequate lubrication of the rollers.

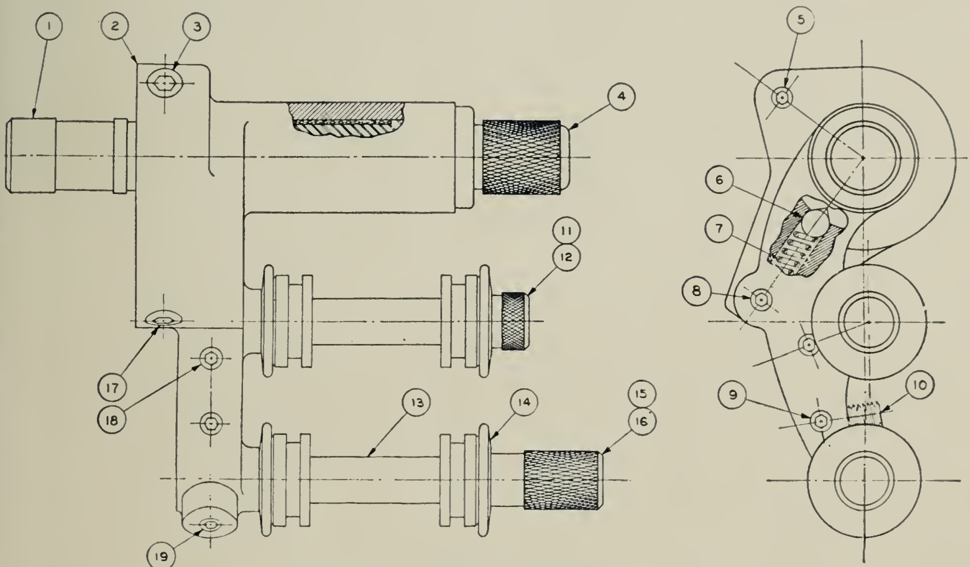


Fig. 14. Double pad roller

Lighting and Wiring

The Model "AA" projector is provided with two auxiliary interior lights. The irregularly shaped structure in the upper right corner of the film compartment houses a lamp for general illumination of the projector interior, with an on-off toggle switch at the lower edge of the housing. The flat contour of the housing mounts a glass shield to protect the lamp, and as an extra safeguard in the event of accidental lamp breakage.

The second light is within the shutter enclosure below the secondary framing aperture. This aperture is slightly above and to the rear of the upper guide rollers. The lamp

socket is carried by the plug-type support inserted from the drive side of the center frame. The framing aperture has a glass shield to prevent the entrance of dirt, and is equipped with two registry pins. The linear relationship between these pins, the secondary aperture, and the actual picture aperture is such that when the film is on the pins and is properly framed in the secondary aperture, it is likewise correctly framed at the picture aperture.

Framing can be checked at any time prior to starting the machine merely by bending the upper film loop back over the framing aperture.

Both lights are controlled by the toggle switch previously mentioned. They are normally equipped with 115 volt lamps, but the sockets also accommodate certain low voltage lamps for service in localities where local regulations prohibit the use of standard voltage lamps within the projector. The asbestos and glass braid insulated interior wiring of the projector terminates in a multi-contact socket and plug unit located in the wall of the drive gear compartment. Sufficient cabled lead wires are supplied attached to the plug to reach inside the projector pedestal or to wall junction boxes, thus insuring that exterior as well as interior projector wiring will be both orderly and safe. The plug and socket connections permit the projector mechanism to be quickly and easily demounted for sound reproducer servicing or for periodic projection room equipment overhaul.

The electrical changeover device is of generally standard construction, although the special model for the "AA" projector includes thermostatic protection for the operating coils and is arranged to make use of the projector's internal changeover wiring, as well as its built-in changeover shutter, which operates in an extra set of guides before the automatic fire shutter in the light path.

Combines All Features

The Motiograph Model "AA", while presenting a vast number of entirely new features, is nevertheless designed so that it affords complete interchangeability with older types of equipment. The base layout, the drive point location, speed and direction of rotation, and the magazine mounting facilities of the "AA" projector are similar to those of other currently available machines. It may therefore be used with any modern sound reproducer and with any make of upper magazine without changing the existent projector drive and without using mechanism mounting plates or special adapters of any kind.

The Heart of the Projector

A Description of the Intermittent Movement

By FRED C. MATTHEWS

The very fact that motion picture films may be projected successfully is due largely to the action of the intermittent movement. This is readily apparent when we review what takes place while the projector mechanism is in operation.

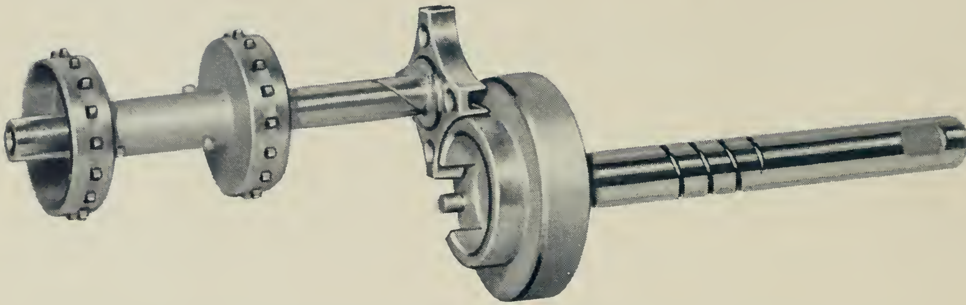
When all standard projectors are properly threaded, the film follows a path from the upper magazine past the upper feed sprocket, through the film guiding system, past the aperture, over the intermittent sprocket, then over the lower feed (take-up) sprocket, and finally into the sound reproducer.

As the film comes down from the upper magazine, it is pulled down at a constant speed of one and one-half feet per second (or 24 separate photographs, termed "frames", by the upper feed sprocket, the shaft of which is attached to the projector mechanism gear train. After the film enters into the film guiding system, it must stop at the aperture and remain absolutely motionless for a period of 1/32nd of a second, in order that the picture on the film may be properly projected on the screen. After this rest period, the movement of the film is sharply accelerated so that the succeeding picture may be pulled into position in front of the aperture. These successive and continuous actions of stopping and starting must take place so rapidly that 24 successive pictures can be projected each second.

The portion of the projector mechanism that creates this intermittent action is known as the intermittent movement—often referred to as "the heart of the projector."

Upper and Lower Loops

Anyone who has ever seen a projector threaded has noticed that the projectionist leaves a slack of film between the upper sprocket and the entrance of the film guiding system which is known as the upper loop. Between the intermittent sprocket and the lower feed (take-up) sprocket a similar slack of film is left—this is known as the lower loop. These loops are absolutely necessary to permit the intermittent action of the film created by the intermittent movement without film breakage, as they absorb the stoppage of the film between the steadily moving upper and lower feed sprockets. While the film is motionless at the aperture, the upper loop of film becomes longer and the lower loop becomes correspondingly shorter. When the intermittent sprocket pulls down the film, the



Position of Motiograph star and cam as the cam-pin is about to engage star slot to pull down a new picture before aperture.

As the star and the intermittent sprockets of most other projectors revolve in reverse direction to the Motiograph Model K star and intermittent sprocket, this figure would illustrate the position of other stars and intermittent sprockets at the point where film has just ceased to be held motionless before the aperture.

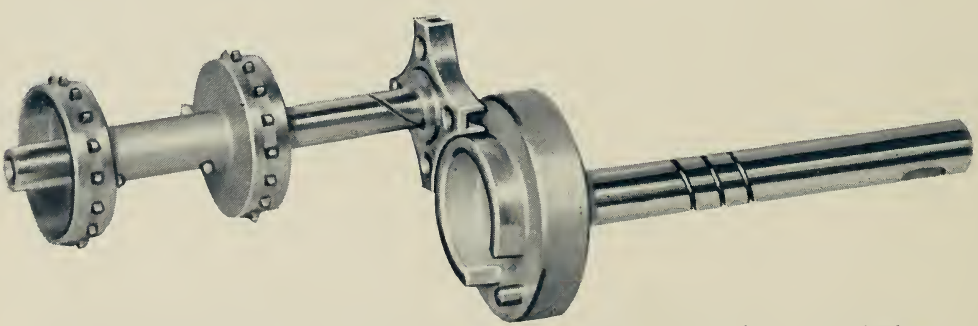
lengths of the two loops are reversed.

The Intermittent Movement

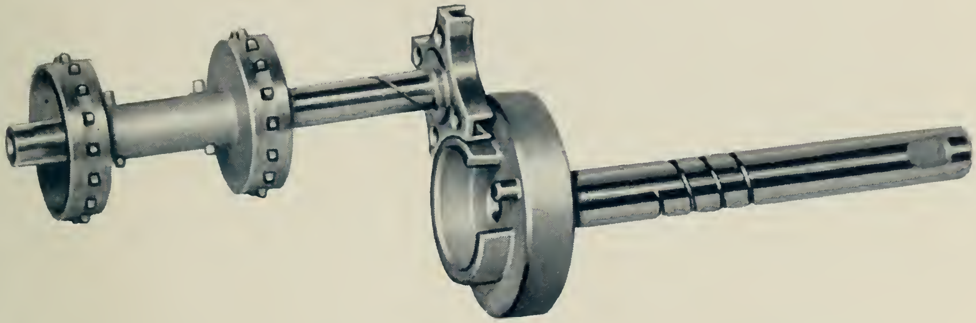
All standard professional 35mm. projector mechanisms utilize an intermittent movement of similar character, the Geneva Movement. This movement consists of a maltese cross of steel known more commonly as the star, and a steel cam upon which is mounted a master pin of steel (the cam pin) which drives the star. This cam also has a flat circular surface by means of which the star (and therefore the intermittent sprocket which is mounted upon the star shaft) is locked immovably at the intervals when each picture on the film is being projected on the screen.

Relation to Shutter

The intermittent movement and the projector shutter are so locked together by a train of gears that the shutter must rotate in exact synchronism with the intermittent movement. Thus, in the interval when the movement of the film is being sharply accelerated, the shutter blocks off the light from the arc lamp, and when the intermittent sprocket stops and the photograph before the aperture becomes absolutely motionless, the shutter blade moves out of the



Position of Motiograph (and other) stars and cams after film has become motionless in front of aperture.



Position of Motiograph star and cam at point where the film is just beginning to become motionless before the aperture.

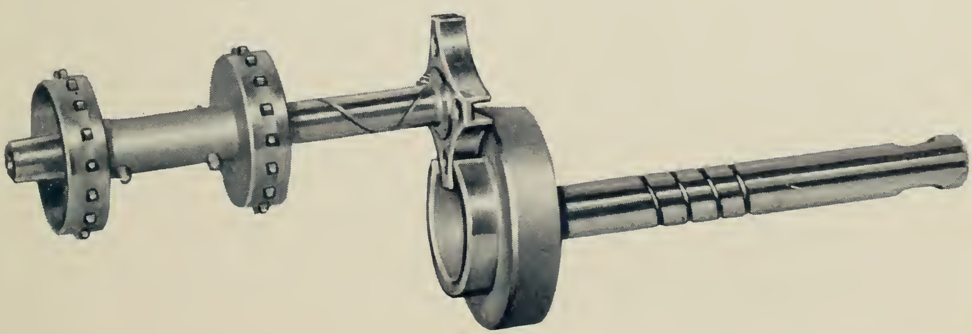
As the star and intermittent sprockets of most other projectors revolve in reverse direction to the Motiograph Model K star and intermittent sprocket, this figure would illustrate the position of other stars and cams at the point where the cam-pin is about to engage the star slot to thus pull down a new picture before the aperture.

way and permits the light from the arc to shine through that photograph to the screen, thus projecting one picture.

Each successive and continuous action of stopping and starting of the intermittent movement is in exact relation to the action of the shutter. The intervals of darkness created by the combined action of intermittent movement and shutter are not seen by the audience, as the screen always appears to be illuminated, due to the rapidity of action of intermittent and shutter.

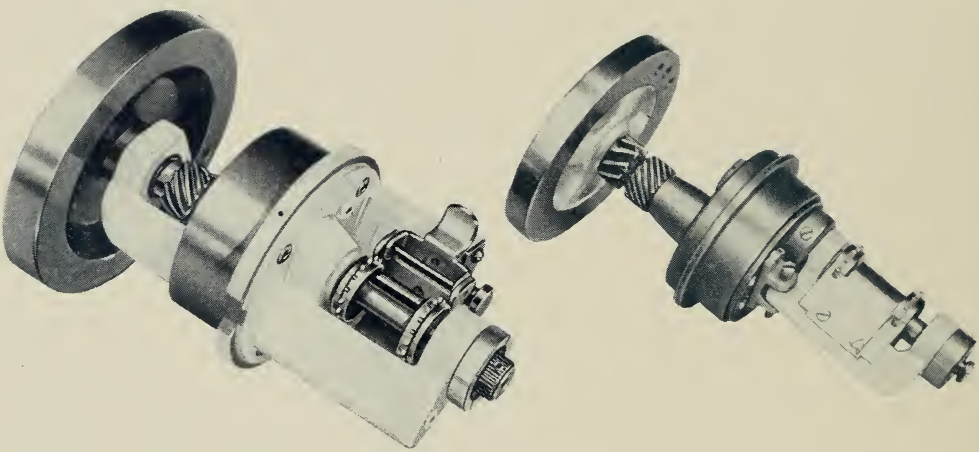
Action of the Intermittent Movement

The cam is in continuous rotation as long as the projector is in motion; when the cam ring is in contact with one of the four radii, the star stands still. When this action is taking place, the intermittent sprocket, which is attached to the star shaft, is standing still and a picture is in place at the aperture to be projected on the screen. When the cam revolves to the point where the cam pin enters into one of the slots on the star, the star, and consequently the in-



Position of Motiograph (and other) stars and cams as new picture is pulled down before aperture.

termittent sprocket, is moved in a rapidly accelerating action to a point where film travel is three times its normal 90 feet per minute pace. This is the action that brings a new picture down the projector aperture. As the cam pin disengages itself from the star slot again, the star and the intermittent sprocket come to a full stop and the succeeding photograph is in the correct place before the aperture.



Comparison of the intermittent movements employed in the Motiograph Model "AA" (left), and the Motiograph Model "K"

Imagine, if you will, the thickness of a human hair split into 30 sections—each of those sections representing approximately 1/10,000th of an inch. That is the accuracy of dimensions that craftsmen must achieve in grinding the radii and slots of the hardened steel stars used in the intermittent movement. The maximum tolerances permitted in other working parts of the intermittent movement are plus and minus 1/1000th of an inch.

This fine, exacting degree of workmanship is absolutely necessary, for unless the intermittent movement performs exactly and faultlessly in bringing down each picture in front of the aperture, each minute fault will be magnified hundreds of times over on the motion picture screen. For example, an unwanted up and down movement of the picture of only 1/100th of one inch at the aperture would be magnified many times over as the picture was projected on the screen, and the resulting picture jump would considerably disturb the patrons.

Variance in Intermittent Movements

It has been said above that the intermittent movements of all modern 35 mm. professional projectors are of similar character. That is quite true, for every Geneva Movement contains a balance wheel, cam, cam pin, star, movement case, intermittent sprockets and bearings, and the attendant gears and pinions to couple the movement to the shutter and mechanism gear trains. One manufacturer utilizes gears within the intermittent housing to drive the cam. Motiograph and some other manufacturers do not use gears.

In the Motiograph intermittent and in the movements of most other projectors, the cam, cam pin and star are usually made of hardened steel. To prevent wear, these parts must operate in a sealed movement case containing oil or grease. It is to be

noted that the intermittent movement is one of the few places in a modern projector where hardened steel is permitted to be run against hardened steel, which accounts for manufacturers' urgent requests that only the lubricants specified by them be used.

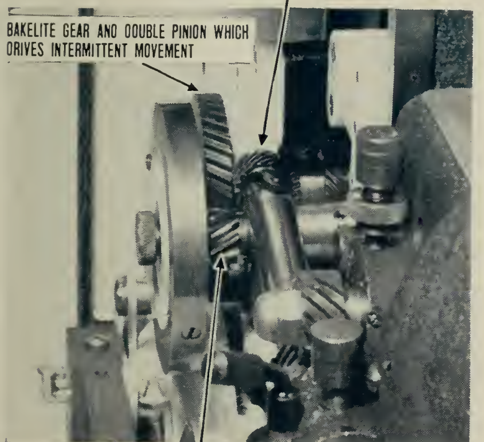
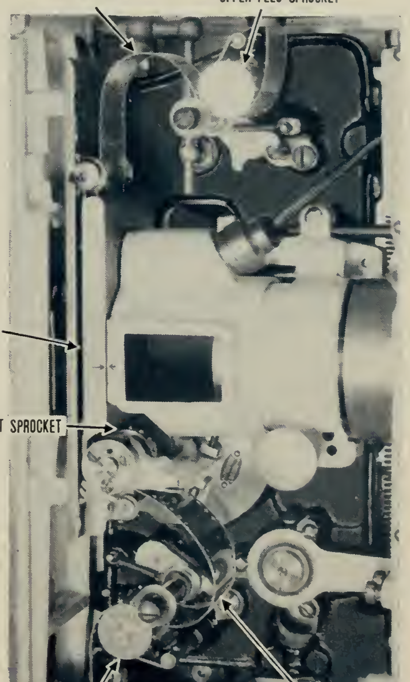


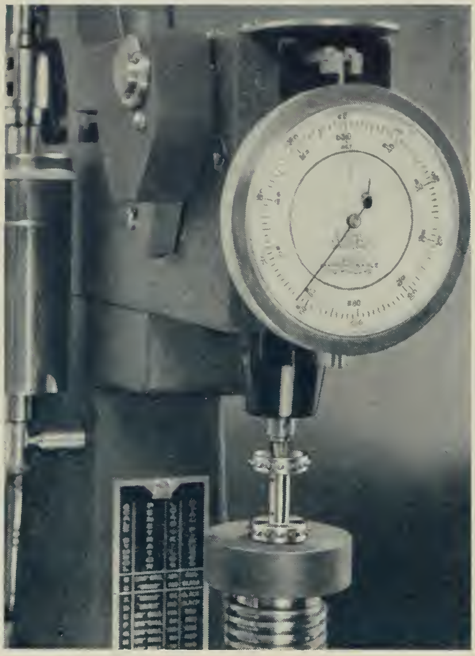
Illustration to show connections of intermittent movement to projector drive and shutter.

Hardened or Soft Sprockets?

Motiograph also hardens its intermittent sprockets, believing that such action increases the life of the sprocket, and as hardened sprocket teeth are almost impervious to wear, there is seldom any picture jump caused by uneven sprocket tooth wear. If wear does ultimately occur, the sprocket may be reversed and used for another comparatively long period. The late Frank H. Richardson, acknowledged as one of the real experts on projection matters, has stated, however—"The intermittent sprockets are not hardened because it was discovered that hardening causes undercutting in the form of a notch in the metal at the base of the sprocket teeth." There are still some manufacturers who apparently concur with Frank Richardson's expressed belief, as they do not harden the teeth of the intermittent sprockets used in their projectors. The author has noted, however, that one large projector manufacturer other than Motiograph changed from using soft intermittent sprockets to hardened ones. While we greatly respect the late Frank Richardson and the work he has done to improve projection practice, Motiograph and other manufacturers think that hardened intermittent sprockets are better than soft ones.



The film path.



A precision hardness tester checks the hardness of sprockets and intermittent movement parts.

The paragraphs immediately above point out the very few variances between intermittent movements of different makes, but the most important variance is in the craftsmanship utilized in the various projectors. If the manufacturer is not capable of achieving minute tolerances, the intermittent movement will wear rapidly and will become noisy. One of the best tests of proper intermittent movement performance is in its silence of operation at various stages of a projector's lifetime. The intermittent movement is an extremely delicate mechanism which may be damaged by improper adjustments, and projectionists are cautioned to follow faithfully the instructions of the manufacturer in making the adjustments provided on all modern intermittent movements.

Microphotograph of a Motiograph sprocket, with the depth of hardening indicated by the dark areas around the edges.

**PROJECTORS-
THE SHUTTER**

The Projector Shutter

Its Relation to Projector Value

By FRED C. MATTHEWS

The primary function of the shutter of a projector mechanism is to impart to the pictures on the screen a better illusion of motion. Without a shutter, the series of pictures would contain numerous disconcerting streaks of light that would prove very tiring on the eyes. A shutter alternately permits light to fall on the film for a fraction of a second and then blacks out the light for a similar period, thus making each picture which appears on the screen stand out more clearly. The shutter, therefore, is one of the really important components of the motion picture projector mechanism.

The shutter has been a recognized part of the projector from the very beginning, although since 1896, when the first commercially practical motion picture projectors appeared, there have been a number of changes in shutter size, form and location. The Optigraph of that year (the predecessor of today's Motiograph) employed one of the first types of shutters. This shutter was located between the aperture and the lens, while each of the two blades was cup-shaped. This principle was retained in the Optigraph and in the Model 1-A Motiograph for some years.

Other projector mechanisms of the early days (including some of the first Motiograph models) had a disc-type shutter

The shutter on the Motiograph 1A Projector (1908), located between aperture and lens, showing how the blades cover the aperture.

located on the front of the mechanism, and consequently in front of the projector lens. In fact, this principle of a front shutter was retained on all projector mechanisms until 1930, when Motiograph changed the location of the shutter from the front of the mechanism to a point between the aperture and the light source. At the same time Motiograph introduced the double shutter. Other projector manufacturers subsequently changed the position of their shutters in similar fashion, although they still retained the single shutter.

Front shutter type employed on Motiograph Model F (1921), with lens uncovered

This change of shutter location was actuated primarily because of the inability of the front shutter to prevent the heat from the light source from pouring on the aperture and the film. Where a front shutter was employed, the heat from the lamp caused buckled film and even brought about a warping of the metal in the projector mechanism itself. This problem was accentuated by the introduction of more powerful arc lamps, which gave out more light and consequently greater amounts of heat.

The change of the single disc-type shutter from front to back partially accomplished the function of dissipating the heat from the aperture and the film. The continued use of mechanisms of the front shutter type are not only the cause of theatre fires and the ruination of many prints, but the patron is being given poor pictures for the money he pays at the boxoffice.

Single disc-type rear shutter

The Double Shutter

While the placement of the shutter between the arc lamp and the aperture was one of the greatest single improvements in projection practice, the disc-type rear shutter was really nothing more or less than the old in-front-of-the-lens shutter, although somewhat enlarged in diameter in

some cases. Other than partially solving the heat problem, it did not materially improve the light on the screen nor the picture definition. In an effort to improve the projected picture, the other major projector manufacturers eventually started to follow Motiograph's practice of using a double shutter.

One manufacturer conceived the idea of equipping a projector mechanism with both a front and rear shutter, each of the two-blade type and mounted on the same shutter shaft. Both the front and rear shutters rotate in the same direction, but they produce the optical effect of cutting the light beam from opposite directions. This is caused by the projection lens being located between the shutters—the lens reversing the beam so that its bottom rays on the lamphouse side are its top rays on the screen side.

Two other projector manufacturers employ two double-blade disc-type shutters operating between the light source and the aperture. These shutters move in opposite directions, as they operate behind the aperture and the projection lens.

Motiograph, the originator of the double shutter, continues the use of a double shutter operating between light source and aperture. These shutters, however, run horizontally or transversely to the light source, whereas in the three double shutter mechanisms referred to above, the shutters operate vertically.

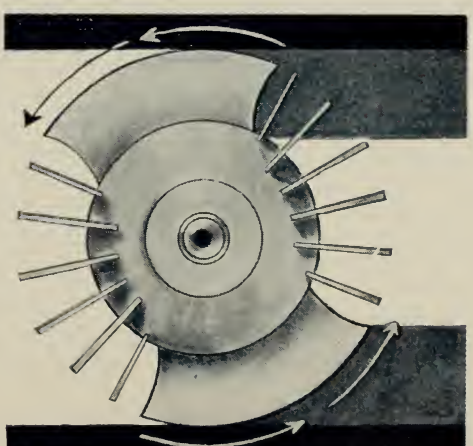
Advantages of Double Shutter

One often hears the question from exhibitors, "Which is the best projector to buy—one with a single disc shutter, or the double shutter mechanism?"

It is true that projector mechanisms with the double shutter are higher in initial cost than those with a single shutter. It is likewise true that all of the better models of the leading makes of projectors are equipped with double shutters. This would indicate that the double shutter mechanism is definitely better—and it is. Here's the reason.

The single disc-type rear shutter has two blades of equal size, one of which (known as the master blade) cuts off the light from the screen during the period in which the intermittent movement is pulling the film into place at the aperture. The second blade (known as the balancing blade, or cut-off blade) is located at the opposite diameter from the master blade, and covers the aperture for a short period of time while the film is at rest. The master blade of the shutter is the one which really gives the illusion of motion to the pictures on the screen, while the balancing blade reduces the flicker that would show on the screen if the shutter had nothing but the one master blade.

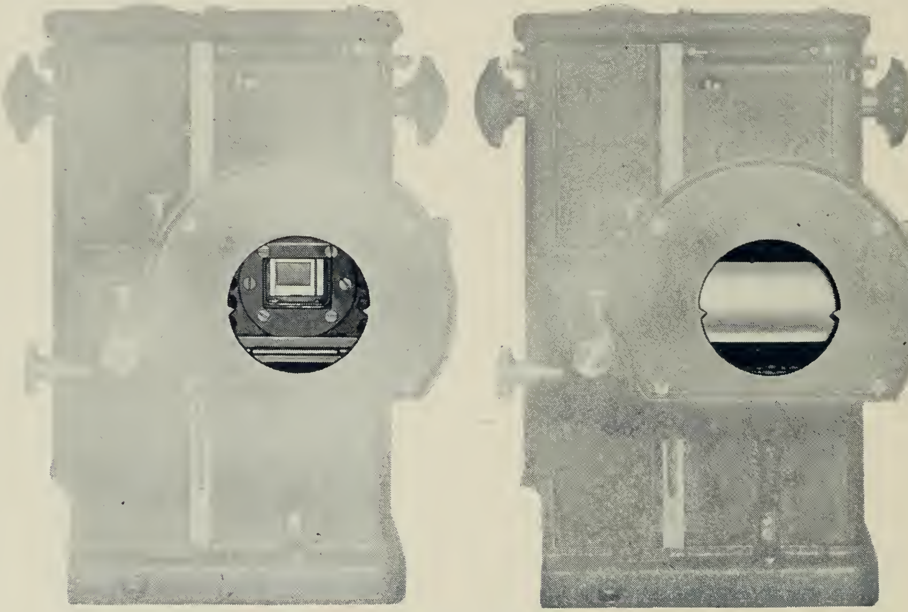
When two disc-type shutters are employed, operating between light source and aperture, there are, of course, two master blades and two balancing blades, with the two master blades cutting the light beam at the same time from opposite directions. Hence, as the time required to cut the light off the screen and restore it is reduced by one half as compared with the single shutter, the screen receives a proportionately



Side view of the Motiograph cylindrical shutter, showing double cut-off of the light beam.

increased illumination. The same effect is produced by the mechanism employing a front and rear type shutter, even though they revolve in the same direction.

"The Motiograph horizontal shutter is a light metal casting rotating on ball bearings and enclosed in a small metal housing. The shutter is positioned transversely (horizontally). In its cylindric surface are two openings through which the light beam passes; the rest of the cylinder serves exactly the same purpose as the blades of the disc shutter . . .



Cylindrical type double shutter with aperture open and closed.

Motiograph Double Shutter

A reference to the illustration of the Motiograph horizontal cylindrical shutter will show that it has but two blades, while the double shutters of other makes have four blades, two of which are master blades and the other two balancing blades. At first glance, therefore, one not proficient in the subject of motion picture projection might gather the false impression that the horizontal cylindrical shutter employed by Motiograph is not a true double shutter type. The Motiograph shutter is, of course, a true double shutter in every sense of the word, as is well brought out by the late F. H. Richardson in his "Blue Book of Projection," as follows:

"What is true of the speed and width of the disc type master blade edges does not apply to this shutter, and for two reasons: it is located closer to the projector aperture and consequently has a smaller beam diameter to cut; the shutter is positioned horizontally or transversely of the beam, the light passed through its center or cylinder so that when one blade is cutting down through the beam, the other is cutting upward, the two interacting at the beam center. Only half the time is required

to cut off the light that would be necessary were only one blade in active operation.

"The Motiograph horizontal rear shutter is shaped at each end of the cylinder to act like a fan or air propeller. From each end air currents are directed toward the center of the cylinder. Each of the two blades of the cylinder has a transverse vane, which, in combination with the propeller ends, sets up air currents and draws them in through the opening of the shutter housing toward the lamphouse. This draws air over the metal of the projector mechanism around the film gate, keeping it and the film at relatively lower temperature and preventing deposits of dust."

It will be seen from all of the foregoing that the projector mechanism employing double shutters gives more light on the screen and consequently a better picture than the single shutter types. In order to accomplish this result, the double shutter mechanism requires more materials, more skilled engineering, and more gears and other mechanical components. While it would therefore obviously be worth more money, the prospective purchaser of a pair of projector mechanisms who is interested in top flight picture presentation for his patrons will do well to select from the four double-shutter types. It is true that three projector manufacturers still make single shutter type mechanisms—probably because there are some theatre owners who consider only price when buying equipment, but it is equally true that they recommend more highly their more modern and superior double shutter types.

Choosing a Projector

Every manufacturer of double shutter type mechanisms makes the claim that their own particular product puts as much, if not more, light on the screen than that of any of their competitors. As a matter of fact, it is my belief that if there is any difference at all, that difference is infinitesimal when all projectors are brand new. The choice of which mechanism to buy accordingly should rest in those factors which have a direct bearing on long-term correct shutter operation.

Shutters are connected by means of shafts and gears to the other components of the projector mechanism. If there is unusual wear on these shafts and gears, it will create lost motion in the gear train that will bring "travel ghost" to the screen. Most manufacturers have a provision for adjusting the shutters in order to eliminate "travel ghost." On some machines these adjustments consist of widening the shutter blades, which, of course, means a marked loss of light as the projector mechanism ages. The projector mechanism with a gear train consisting of hardened steel and bakelite gears is capable of much longer operation without adjustment than one employing soft iron gears.

Ball Bearings

Their Use in Projection and Sound Equipment

By H. THORWELL MATTHEWS

Nothing rolls like a ball. From the earliest days of civilization, man has been concerned with making his implements and machines move with the greatest speed and the least amount of friction. The ball bearing may be said to represent the culmination of this effort.

Because the steel ball presents a uniform and calculable resistance at whatever angle the load may be applied, it possesses inherent advantages not equalled by any other form of rolling body. The cylindrical roller, for instance, has two ends, but there are no ends to a ball. Its axis of rotation and its direction of load need never be fixed artificially.

Balls Roll Naturally

In the correctly designed and manufactured ball bearing, sliding friction is so reduced as to be of no real consequence, for the balls in a bearing are the most perfect self-aligning members known. They require no guidance other than the groove in which they roll.

The function of the separator is simply to space the balls properly. While sliding friction occurs between the balls and the separator, the only contact is in the vicinity of the poles, where surface speed is very low. As a film of lubricant is easily maintained at this point, the amount of friction is immaterial.

There is but one remaining source of friction which affects the bearing, and that is the fluid friction caused by movement of the lubricant. With high speed ball bearings, fluid friction is avoided by the use of small quantities of light oil which are all that are needed for lubrication.

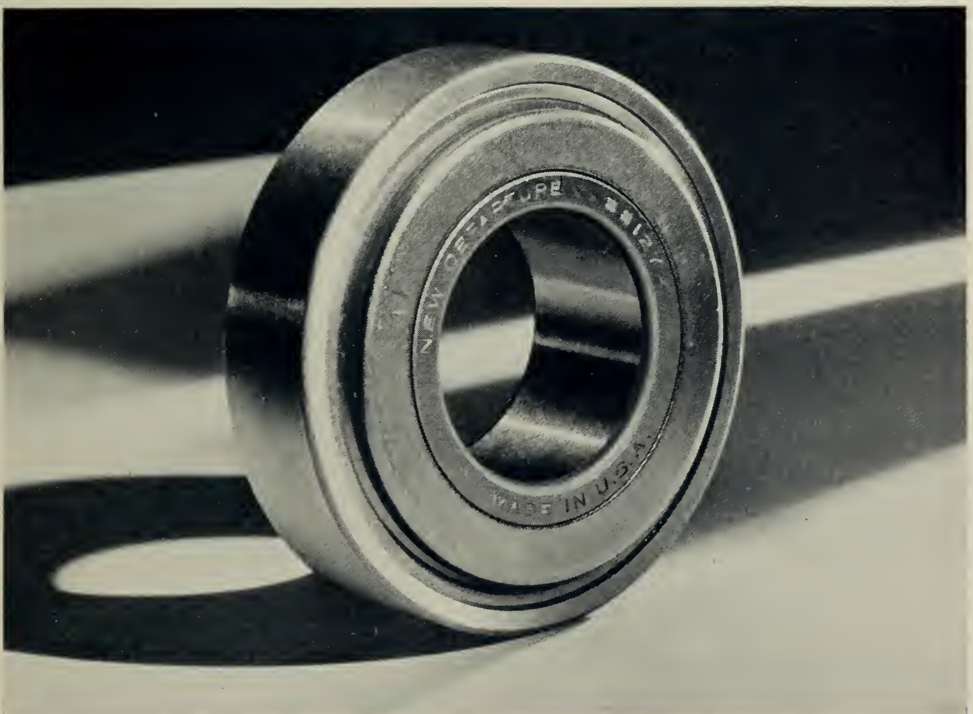
The amount of friction in any type of bearing is very largely the result of the amount of wear which takes place. Ball bearings are the only type of anti-friction bearing that can be successfully sealed and lubricated for life, so that they may run for many years without the least attention.

Ball Bearings Decrease Wear

Let us look further into this problem of

wear, for this is a factor which definitely limits the accuracy and the period of usefulness of a machine. When we speak of wear, we are thinking of motion, and as motion requires the use of bearings, it is plain that if we can solve the bearing problem, we will be able to do much to reduce wear and prolong machine life. There is much truth in the statement that the life of a machine is governed by the life of its bearings.

The steel balls of a ball bearing are in contact with the separator, but as no guiding pressure is exacted here, wear from such causes is entirely absent. The separator has no other function than to space the balls equally within the race rings. If no separator were employed and the available space between the race rings completely filled with balls, it is obvious that a certain amount of wear would take place through sliding contact and rubbing velocity. The use of a separator not only prevents this contact, but does so in such a way as to avoid any appreciable amount of wear. With properly designed and manufactured ball bearings, the balls are in contact only in the vicinity of the poles, where the surface speed is very low. The combination of slow polar surface speed, light pressure and an ample cushion of oil renders wear an entirely negligible factor.

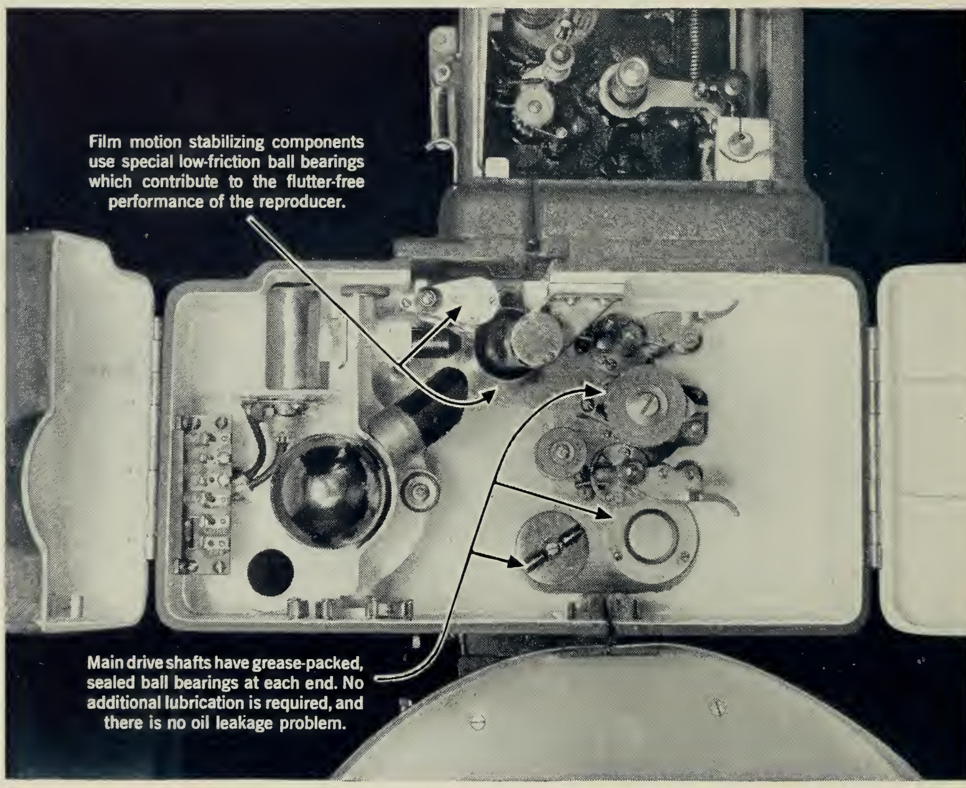


The sealed type of ball bearing, lubricated for life.

Permits High Machine Speeds

The term high speed is not strictly a matter of revolutions per minute alone,

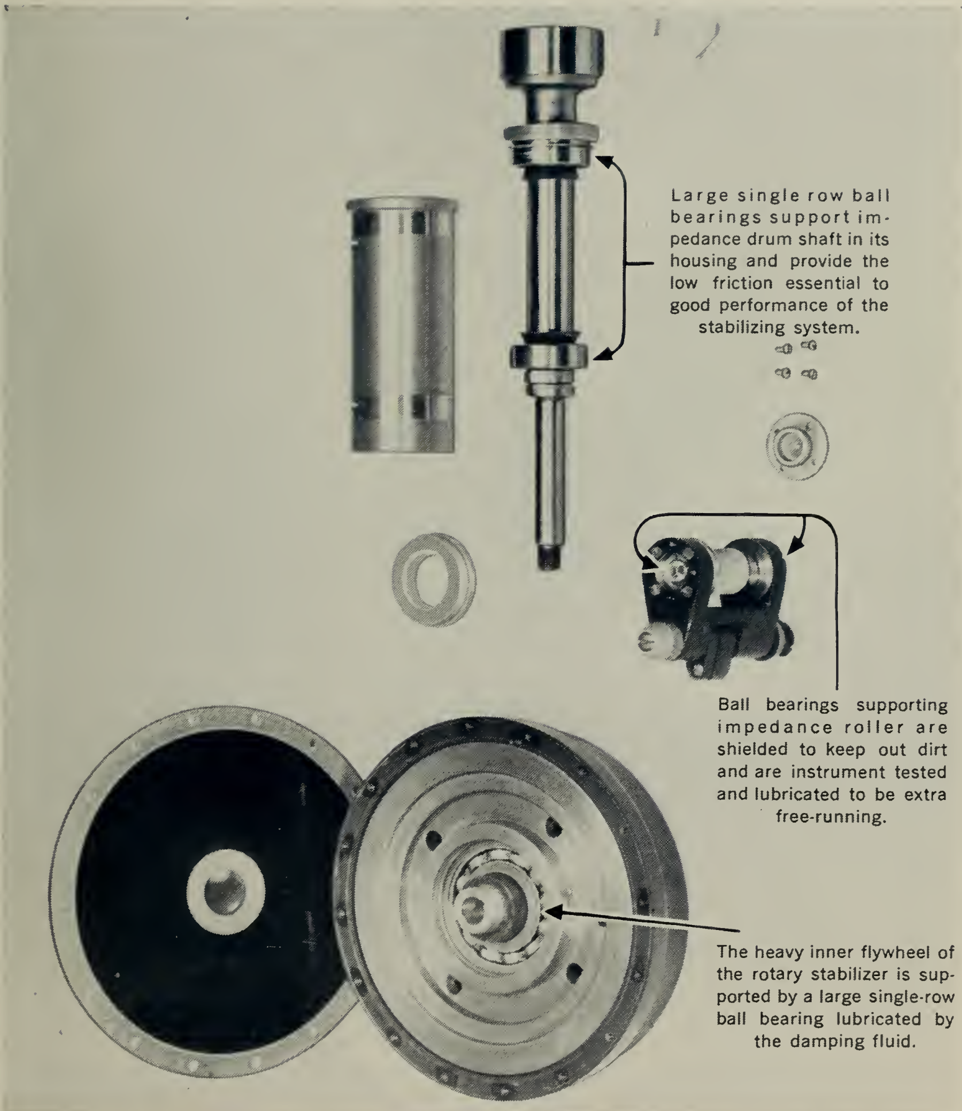
since what may be considered high speed in one machine would not necessarily be so for another of a different kind. Regardless of exact speed, however, a bearing employed for any high production machine speeds must embody certain essential features.



The Motiograph-Mirrophonic SH-7500 Reproducer is ball bearing equipped throughout.

The first of these is low frictional loss. Friction increase is first denoted by higher operating temperatures. Since one of the duties of a lubricant is to carry away heat, the matter of lubrication becomes more difficult and involved as speed is increased. As ball bearings operate best with no more than a slight film of oil, it is clearly demonstrated that the losses due to sliding friction within a precision ball bearing are very small indeed.

The ball is unique in that it has no ends and therefore no weak spot. A steel ball of the type employed in a ball bearing possesses marvelous strength. In an interesting demonstration, a ball was placed on a solid block of steel and resisted a pressure of ninety tons from a hydraulic ram before the ball was forced into the steel block up to its full diameter. At the completion of the experiment, the ball was still round, while the steel block was distorted and cracked.



Film motion stabilizing components of the Motiograph-Mirrophonic SH-7500 Reproducer partially disassembled to show use of ball bearings.

Better Projectors

Ball bearings, however, are employed in motion picture projection and sound equipment not so much for their strength as for the reduced friction and the accuracy required in these types of precision equipment. It is also highly important that heat be held to a minimum in theatre booth

equipment. This is admirably accomplished by the ball bearing with its relatively slight degree of friction.

Another important advantage of the sealed ball bearing is that it requires no lubrication. While ball bearings have always been employed in projectors and sound systems, they will be featured to a far higher degree than ever before in the better postwar equipment.

PROJECTORS-TENSION SHOES

Projector Tension Shoes

Motiograph's Wide Latitude Adjustment

By EMIL WIENKE

The primary function of the tension shoes is to flatten out the film as it passes through the projector film gate so that there will be no tendency for the projected picture to have an in and out of focus condition.

As prints are received by our nation's theatres in widely varied condition, it is highly desirable that the projectors be equipped with a device that will permit instantaneous change of shoe pressure during operation, for with such a device a good, clearly defined picture can be obtained regardless of the condition of the print.

The majority of projectors installed in our theatres do not have such a device, and consequently, unless the degree of tension of the shoes of these projectors is in direct relation to the condition of the print being run, a generally poor picture could easily result. Variance in quality of the projected picture is particularly noticeable when a new print and an old one are run during the same show.

The importance of furnishing in their projectors a variable shoe tension device capable of operation while the projector is running is being recognized by the three leading manufacturers of projectors. Two supply such a device on both models they produce, and another in its higher priced model.

Thumb Screw Tension Setting

In the projectors made by two manufacturers, the degree of shoe tension can be changed by turning a thumb screw. These devices make possible a decided improvement in the projected picture over that possible with projectors without such a device. The degree of tension being applied by thumb screw operation, however, is still subject to human error, as the screw of one

tension device could easily be turned farther than the screw on the other projector in the booth. It is possible, therefore, that there could be a variance in the projected picture from two machines in the same booth, even though the print being run were in identical condition.

In order to determine the proper degree of shoe tension that should be applied to film in various conditions to produce maximum screen results and minimum wear on film, Motiograph conducted a long series of tests. Brand new film was run at varying degrees of shoe pressure to locate the lowest possible degree of pressure at which a fine quality picture resulted. After running a long series of tests, it was decided that a pressure sufficient to cause a film pull tension of eight ounces would produce best results. Similar tests were made with film that had passed the first run stage and it was found that a tension of twelve ounces was most desirable. Badly buckled, often spliced film required the much greater tension of twenty-four ounces to produce anywhere near satisfactory picture results.

Cam Operating Unit

To give any of the three degrees of pressure as required, Motiograph provides in its projectors a cam-operated tension device that permits the projectionist to flip a small lever to bring about the desired degree of tension. Careful checks of installations have shown the wisdom of having but three definite degrees of tension instead of a large number of different degrees.

While it is true that wear on film is increased as shoe tension is increased, Motiograph tests showed that the extent of wear at the greatest degree of tension employed in its projector was not of great importance, considering that the heavier tension is needed only on films which are near the end of their useful life. These tests did clearly prove, however, that extreme shoe pressure could create excess film wear by forcing the film out of alignment if the film were not properly edge-guided through the film gate. This is particularly true with shrunken film.

The tests also proved that the best method of guiding the film through the film gate was the provision of two film guide rollers at top and bottom of the film gate which would automatically adjust themselves to the width of the film being run. For this reason, Motiograph discarded the conventional studio guides employed in many projectors in favor of two self-adjusting film guide rollers. Studio guides work only on film of the exact dimensions for which they are set, and are either useless or cause buckling of film if other degrees of shrinkage are run.

PROJECTORS-MAGAZINES

New Types of Magazines

Mark Significant Design Improvement

By H. THORWELL MATTHEWS

Older type 2,000 feet upper magazines are 18 inches in diameter and 3-⅛ inches deep from their back wall to the magazine door. The "AA" magazine is of the same diameter, and is 3-⅞ inches deep. The greater depth of the "AA" magazine permits the use of old exchange reels without scraping the magazine body or magazine door.

Another improvement in "AA" upper magazines is the completely new fully enclosed adjustable reel shaft tension device.

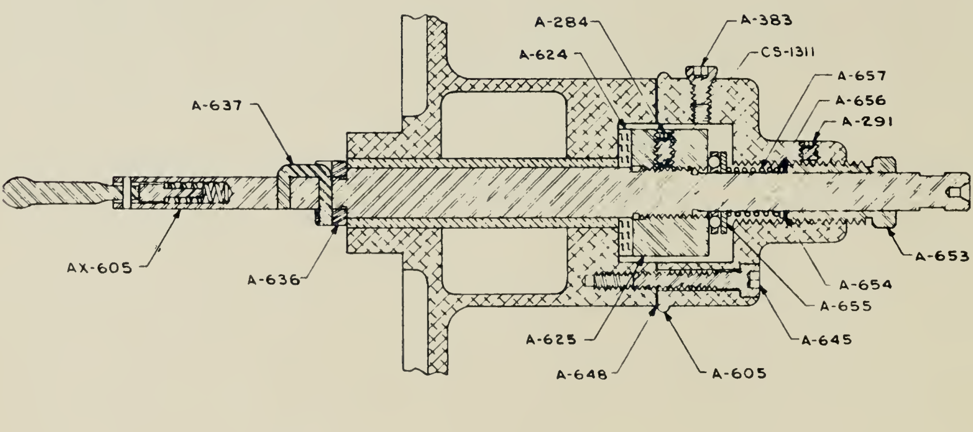


FIG 8

Figure showing design of the adjustable reel shaft tension device.

This device, once the desired tension is set, can be locked permanently into the correct tension to remain without slipping for years.

The design of the adjustable reel shaft tension device is simple.

Here is the way it works. Loosen the lock screw No. A-291, then turn the adjustment screw No. A-653 in the desired direction (to increase tension, turn to right—to decrease tension, turn to left). When the desired tension is obtained, tighten the lock screw No. A-291, and the reel shaft will continue to have the correct tension for years.

Projectionists, particularly, will want to know how just turning the adjustment screw No. A-653 will bring about the correct tension, so we will carry on with the explanation. When you turn this screw,

Reverse side of the Motiograph "AA" upper magazine, showing reel tension device.

you either increase or decrease the compression of a spring, No. A-657, against a thrust bearing, No. A-655, which creates a drag against a leather washer, No. A-624. This action brings about the desired degree of tension in the reel shaft.

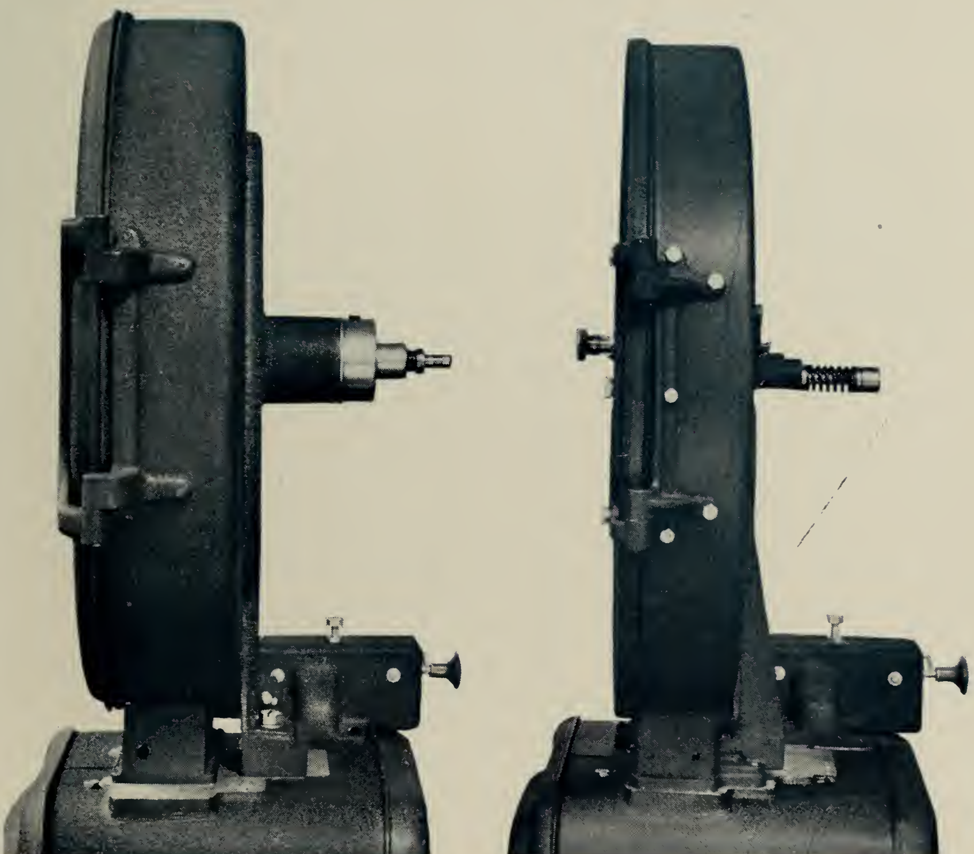
It will be noted that the reel shaft is of conventional size where the reel is attached, but is larger as it fits into the casting of the tension device to give the reel shaft greater rigidity. The shaft again is reduced to conventional size as it emerges from the rear of the magazine to provide a support for the reel end alarms that mount on the upper magazine shaft.

Like the "AA" mechanism, lubrication of the upper magazine reel shaft is very simple. One removes the four A-645 socket

The Motiograph Model "AA" upper magazine.

cap screws to slide off the A-605 hub casting, cleans out the old grease from the inside of the hub, and refills once or twice yearly. The oil cup on the hub of the spider casting should be refilled three or four times a year with a few drops of oil.

attached fire-trap roller units. "AA" upper magazines, therefore, may be ordered separately, and may be said to offer a replacement for the 16 inch diameter upper magazines in use in so many hundreds of theatres.



Comparative views of the Motiograph "AA" upper magazine and an older type of magazine (right) Note the increased depth and the upper reel tension device of the "AA" magazine.

The "AA" upper magazines are designed particularly for use with the "AA" fire-trap roller units, later described, but "AA" magazines will fit on projector mechanisms of most other makes or models which have

Fire-Trap Roller Section

Motiograph delivers with its "AA" projector mechanism a separate casting which contains four fire-trap rollers. By removing two Allen screws, these fire-trap rollers can

be removed between reels from the magazine for routine cleaning and inspection without removing the magazine from the mechanism. As faulty, sticking upper magazine fire-trap rollers are difficult to remove and replace, they are consequently a source of considerable film damage. Motiograph has therefore eliminated a source of magazine that can be used with any sound reproducer or projector mechanism without the necessity of supplying different lengths of reel shafts or reel shaft pulleys placed in different positions on the shaft. The "AA" lower magazine has inbuilt pulleys on the lower magazine take-up casting which permit perfect alignment of the belt between

The fire rollers of the upper magazine, with rollers shown disassembled at the right.

scratched prints. This unit, No. AX-90, may be ordered separately and used as a replacement on any standard projector mechanism with the old upper magazine body or the new "AA" upper magazine. (Motiograph Model "K" magazines can only be replaced with these assemblies and new "AA" magazine bodies.)

The "AA" Lower Magazine

For the first time, a projector manufacturer has designed and constructed a lower

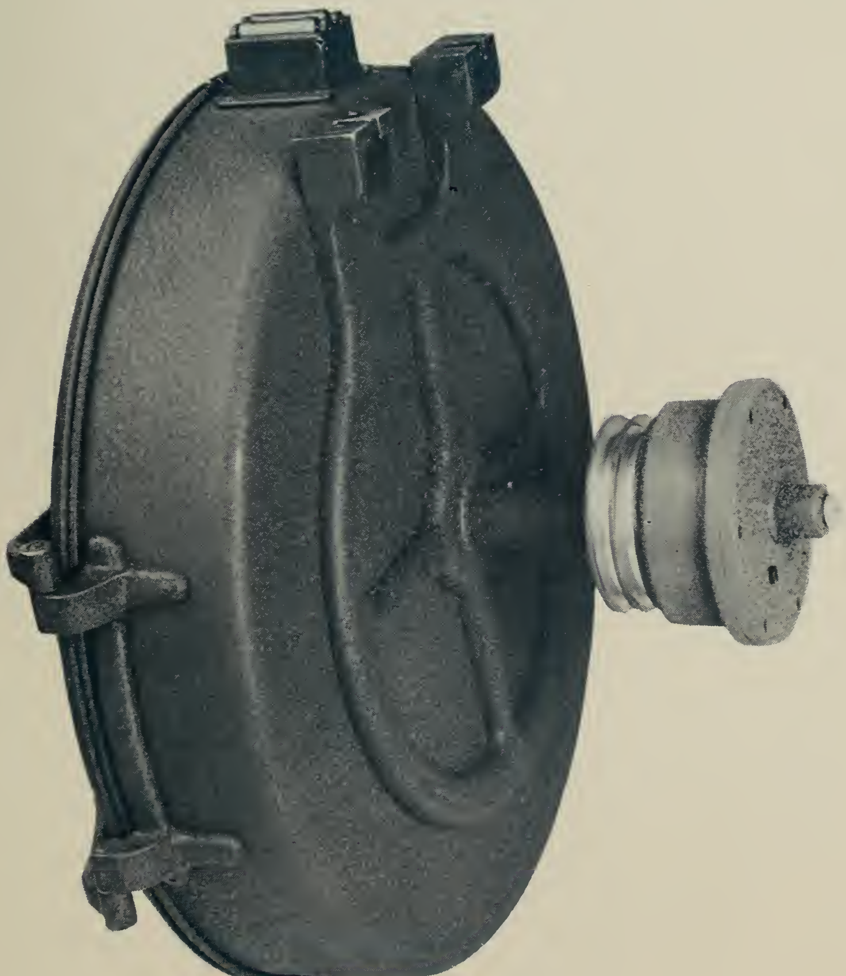
take-up and sound reproducer. These pulleys can be used in conjunction with a round belt or the modern V belt to be supplied with "AA" lower magazines.

Like the "AA" upper magazine, the "AA" lower magazine is nearly a full inch deeper than older style magazines, so that there will be no problem of bent reels scraping the sides or door of the magazines. Hinges are stronger than those on older style magazines, and opening the improved catch makes a simple one-handed operation of opening and closing the magazine door.

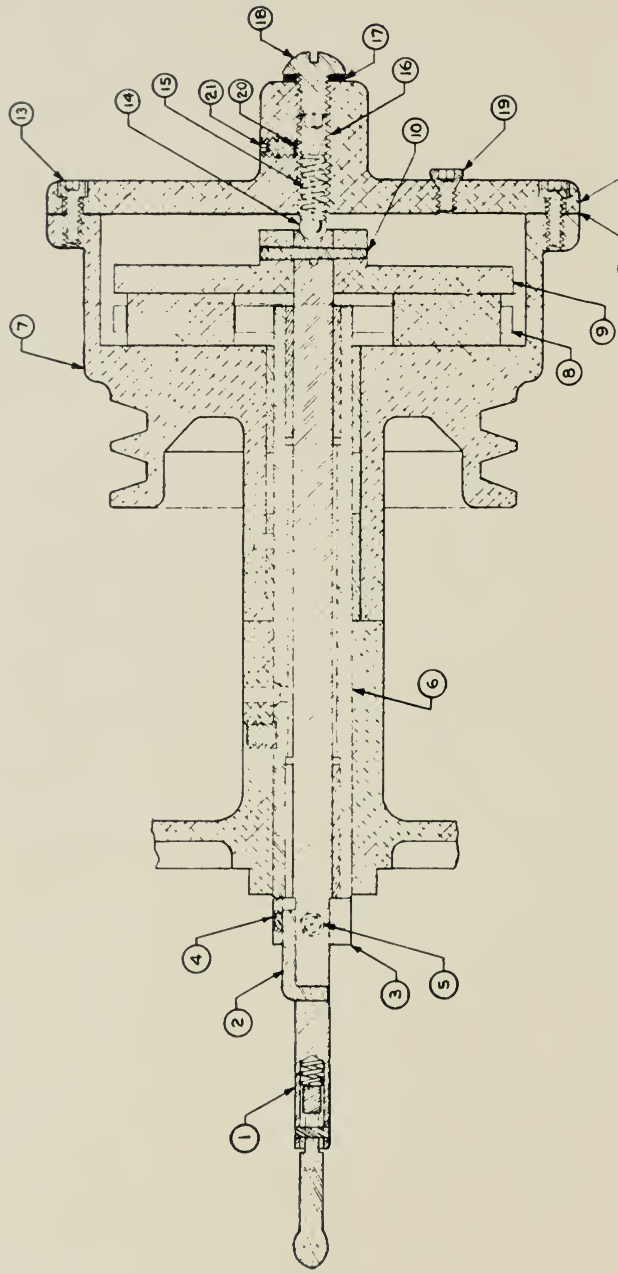
The upper portion of the fire-trap roller casting is curved to fit the contour of the magazine body, making the connection of magazine to soundhead much better than could be gained with lower magazines with a straight top on the fire-trap roller casting. This arrangement also facilitates the final steps of the threading operation.

Most important of the new features of the "AA" magazine is the new take-up assembly which, when set at the desired tension, simply cannot get out of adjustment. This new and improved take-up also offers no lubrication problems, for annual lubrication at only one point is required. To lubricate, one simply removes oil plug No. 19, fills with oil up to the oil hole and puts back the plug.

Reference to the Drawing will show that the take-up is fully enclosed—there



The lower Motiograph "AA" magazine. Note the completely enclosed takeup.



The take-up assembly of the Motiograph "AA."

are thus no springs to gather dirt, grit or oil. Setting the proper degree of tension is just as simple as setting the tension of the upper reel shaft, and once set there is no likelihood of the take-up getting out of adjustment.

To secure the desired tension of the lower magazine take-up one loosens lock screw No. 21 and removes screw No. 18 and its attendant gasket No. 17. The internal set screw No. 16 should then be turned in the direction necessary to obtain the desired tension (right to increase tension—left to decrease tension). When the desired tension is attained, insert screw No. 18 and gasket No. 17 and tighten lock screw No. 21.

When the internal screw No. 16 is turned, it forces a ball bearing No. 14 against the No. 9 take-up friction disc, which engages with the No. 8 cork retainer disc, and which in turn presses against the inner wall of No. 7 take-up pulley casting. The degree of pressure thus applied remains constant, as the lock screw No. 21 prevents the internal screw No. 16 from turning.

R*eel* E*nd* A*larm*

The Ace Reel End Alarm is designed particularly for use with reels of motion picture films, and has for its primary object to provide a signaling device in the form of a bell with which a hammer is engageable and controlled by a gravity-actuated arm arranged to ride on the roll of film in a manner to sound an alarm when the unwinding of the film has reached a predetermined point.

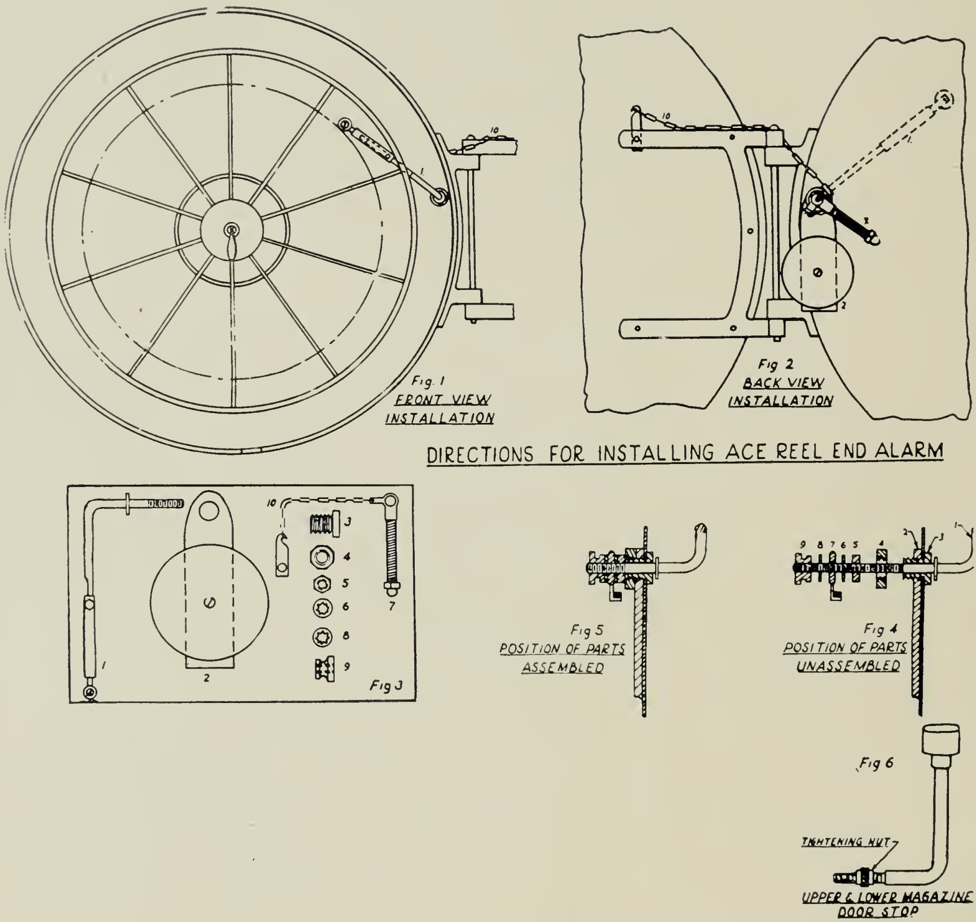
There are a number of important components of the Ace Reel End Alarm. One of them is a roller bearing on the free end of the gravity actuated arm which contacts the roll of film and is a self-adjusting type, so that periphery of the roller will at all times bear flatly against the surface of the film to prevent injury thereto while the film is being unwound. Another part is a chain which travels over the collar and connected to the front door, which raises the arm as well as the hammer, so as to permit free removal of the reel for replacing the film. There is also a coil spring with a hammer to hit the bell, emitting a very clear, alert tone. It is made in two sizes—for 16-inch Magazines and 18-inch Magazines, and sold by leading motion picture supply dealers.

The Ace Reel End Alarm installed on a projector magazine

Easy to Assemble

The Alarm comes fully assembled and in order to install this alarm on your magazine, a few simple instructions must be carried out.

Disassemble all parts and lay out as shown in Fig. 3. Drill a 5/16″ hole in magazine 1¼″ below the top hinge on the extreme left side, close to side wall of magazine as shown in Fig. 1. Install No. 3 bushing by screwing it into plate No. 2 all the way in; as No. 3 bushing has its own lock washer, then lock with No. 4 locknut. Now put through magazine No. 1 shaft up to stop cap and lock with No. 5 locknut to end of threads, leaving enough for the shaft to work free. Then put on No. 6 washer, No. 7 spring, No. 8 washer and last No. 9 binding nut as shown in Fig. 4 and completed as in Fig. 5. There is a felt



Series of diagrams to illustrate installation of the Ace Reel End Alarm

pad which is glued to one side. Dampen with a little water the glued side and attach to the inside of magazine where the ball bearing roller comes down and hits the side.

You are now ready to adjust the Reel End Alarm. Take No. 10 chain hook and put under screw on hinge of door Fig. 2. Rest Ball Bearing Roller on pad and have spring hammer $\frac{1}{4}''$ away from bell and tighten No. 9 binding nut. Put chain under spring around top and continue as shown in Fig. 2. Now with door open, lift up ball bearing arm to the top of magazine, so that it is flush with side wall. Attach chain to No. 10 hook. If arm is not completely flush against magazine, move No. 10 hook backwards or forwards by loosening screw which holds it in place.

Fig. 6 is a rubber bumper for upper and lower magazine which prevents chain from stretching and door banging against porthole, etc. These may be purchased from your local supply dealer with full instructions for installation.

BEARINGS MUST BE OILED WITH FINE OIL—one drop, twice each week.

Arm of the alarm in position against the film

PROJECTORS-LENSES

Coated Lenses

An Aid to Better Projection

By DR. A. F. TURNER

Bausch & Lomb Optical Co.

In 1939 "coated" lenses were offered to the profession. They gained immediate and widespread acceptance, and have grown in popularity ever since. Today in thousands of projection booths throughout this country and abroad, discerning projectionists rely upon these lenses to put the "extra punch in the picture" due to greater screen brilliance and contrast in both black and white and color productions.

These early coated lenses were accepted largely on faith and upon the reputation of the manufacturer, with little reference to the basic facts about coated lenses and how the coating affects the optical performance. Below are summarized a few of these facts and the reason why "coated lenses" may be considered standard equipment.

The improvement which coated lenses have on screen image quality can be readily inferred by a casual examination of such a lens, especially if it be compared with an untreated one. In the first place, the "insides" of the barrel of the filmed lens are more easily seen than of the untreated one. The explanation is that the glare of light reflected from the unfilmed lenses obscures one's view into the lens barrel. It is the same difficulty that one has in looking into a darkened room through a window on which the sun is shining. The coating reduces the glare to a point where one can look through it, as it were. Sometimes, in fact, with the illumination just right, it seems as if the lenses were missing.

Secondly, if a piece of paper is held behind the two lenses, it appears considerably brighter when viewed through the filmed one. Evidently more light is passing through the coated surfaces than through the uncoated. The illustration is a photograph of a pair of projection lenses—one coated, the other not.

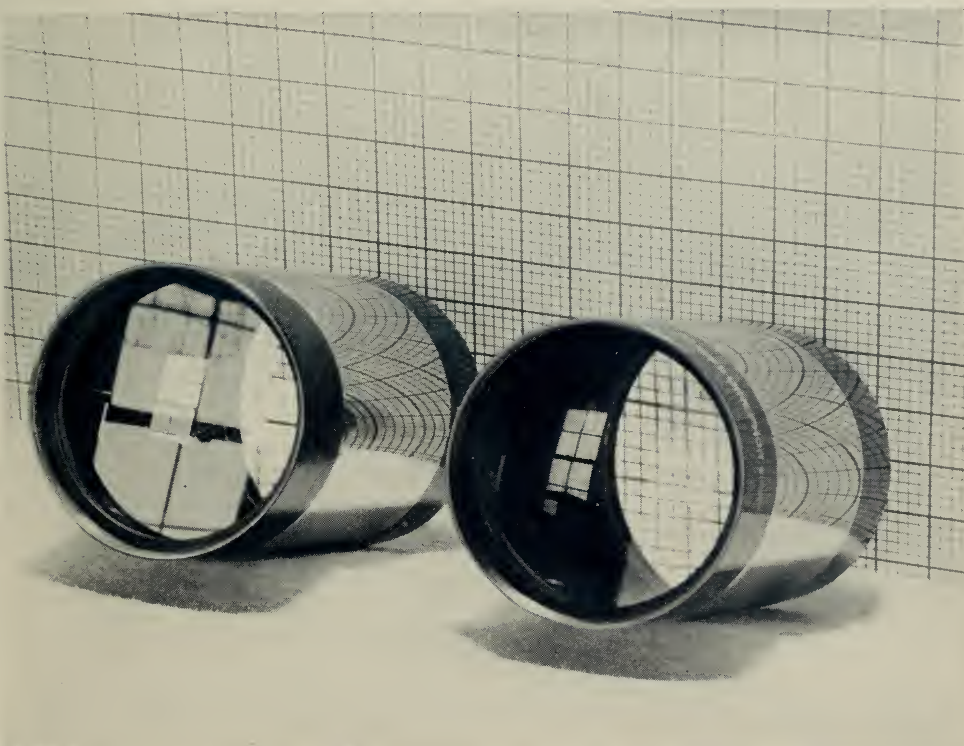
Reduction of Glare

The reduction of the glare from the lens surfaces and the increase in transmission brought about by the surface treatment go hand in hand. The one is the result of the other. Most of the light which before coating is reflected as glare is reclaimed by the coating process and allowed to pass through the lens as useful image forming light. Consequently, a treated lens will furnish a brighter screen image by 25 percent or more.

If there is any doubt on this point, just make an experiment sometime of measur-

ing your screen brightness with an illumination meter, first with an ordinary lens, then with a coated lens of the same type. The large difference between the two will make it apparent why it is unsatisfactory to attempt to use a coated lens in one projector and an uncoated in the second. The sudden jump in screen brightness upon changing over between reels is as disconcerting to the audience as to the operator. If the latter is having his first experience with coated optics, he may be tempted to think that the current in the projector with the untreated lens has dropped or that the carbons are out of adjustment.

The other improvement in image quality obtained with coated optics has to do with the effects of eliminating flare. In this connection the results on the screen are of a more subtle nature than the very apparent brightness increase described above. They are, however, as definite to the exacting projectionist as the improvement he obtains in replacing a single lens by a more perfectly corrected one which will give him a sharp focus from the center out to the very corners of the screen.



Comparison of uncoated (left) and coated projection lenses, showing marked reduction in reflections and fredom from glare in the coated lens.

Prevents Loss of Light

The coated lens goes a step farther, not by increasing sharpness of focus, but by enhancing the contrast. Blacks become

blacker—highlights become crisper—and colors take on their full richness and brilliance, not being diluted with scattered light. This is all due to the reduction of flare in the lens, brought about by the coating process.

As the projectionist commonly uses the term "flare," it is a haze covering the screen and injuring contrast in the same way as the footlights would were they left on during a performance. This flare is closely related to the above mentioned glare, which made it difficult to see the inside of the barrel of the ordinary uncoated lens. Each of the glass surfaces in the assembly reflects a small portion of the light falling on it. Some of this reflected light may again be reflected as another surface, and so on. The net result is that a fraction of the light initially falling on the lens becomes a sort of errant light, either wandering toward the screen or toward the film strip—in both cases useless, as far as image formation goes. In fact, it is worse than useless, because it clogs the true image with an out-of-focus haze.

Although the amount of light lost by reflection from a single surface seems insignificantly small—possibly five percent—nevertheless in a well corrected lens with its several elements, it adds up to a rather large value. Thus, in a four-element lens, the eight surfaces subtract 35 percent of the total light passing through them, and of this 35 percent, a considerable portion may ultimately reach the screen to the detriment of contrast or of color saturation. Coating the same lens greatly decreases the reflection loss from each surface. This not only allows correspondingly more light to be transmitted directly to the screen, but at the same time practically eliminates the errant multiply-reflected light which gives rise to the flare so damaging to contrast.

Projection lens flare is often more difficult to evaluate than camera lens flare. In a camera lens, flare can take the form of sharply defined ghosts, the existence of which, when they appear, is certainly definite. The existence of haze, on the other hand, may be overlooked except to an experienced eye. If a direct comparison be made, however, between the images from an uncoated and a coated lens, such a comparison leaves no room for doubt about the superiority of the coated lens.

Nature of Coatings

The coatings to which the lenses owe their augmented brilliance and freedom from flare are exceedingly thin transparent films with thicknesses of about four millionths of an inch. Their behavior is easily explained in terms of the interference of light, which is also the underlying cause of the colors of soap bubbles.

The lens coatings also appear colored in reflected light. Although these colors may appear to be very pronounced or saturated, practically no perceptible tint is imparted to light transmitted through the lens. It would lead too far to go deeply into the theory of these effects here. It must suffice to say that the lens coatings are practically equal in effectiveness for all wave lengths or colors of the spectrum. There need be no hesitancy in using coated lenses for color movies. On the contrary, it was with colors that they first gained popularity, having been supplied for the premieres of "Gone With the Wind."

* * *

Here are three essential formulas which many managers and operators may have known in the past, but can't seem to remember:

To find lens size, divide throw by screen width, and multiply by .825.

To find throw, multiply lens focus by screen width, and divide by .825.

To find picture width, multiply throw by .825, and divide by lens focus.

* * *

The interior of the projector lens barrel is painted black to prevent reflection of light. If the metal should show, it should be recoated immediately, using a black paint well thinned out with turpentine.

Projection Lenses

Their Design, Construction and Care

By E. O. KOLLMORGEN
President, Kollmorgen Optical Corporation

The entire investment in a theatre and its equipment, from the inviting marquee to the closing curtain, is aimed at a single objective—projection of a high quality image, with faithful sound, amid pleasant surroundings. Since patrons pay to see the picture, it is evident that no effort should be spared in throwing the best possible image on the screen. To this end, projectors, light sources, lenses—even the film itself—have been developed to a point approaching perfection. However, the picture can be no better than the lens which projects it. With this obvious but often forgotten fact in mind, let us consider just what a good projection lens has to do, and what in turn we have a right to expect from it.

Requirements

The requirements of a projection lens are both optical and mechanical. While the mechanical problems yield to straightforward design, the optical problems—in theory, at least—cannot be solved completely. In other words, there is no such thing as a perfect projection lens. The best we can do is to make skillful compromises between conflicting requirements. In making these choices, we take advantage of the psychological aspects of human vision. If we can keep the imperfection in the projected image too small to be noticed by the eye, we have—for all practical purposes—achieved our goal.

Brilliant Illumination

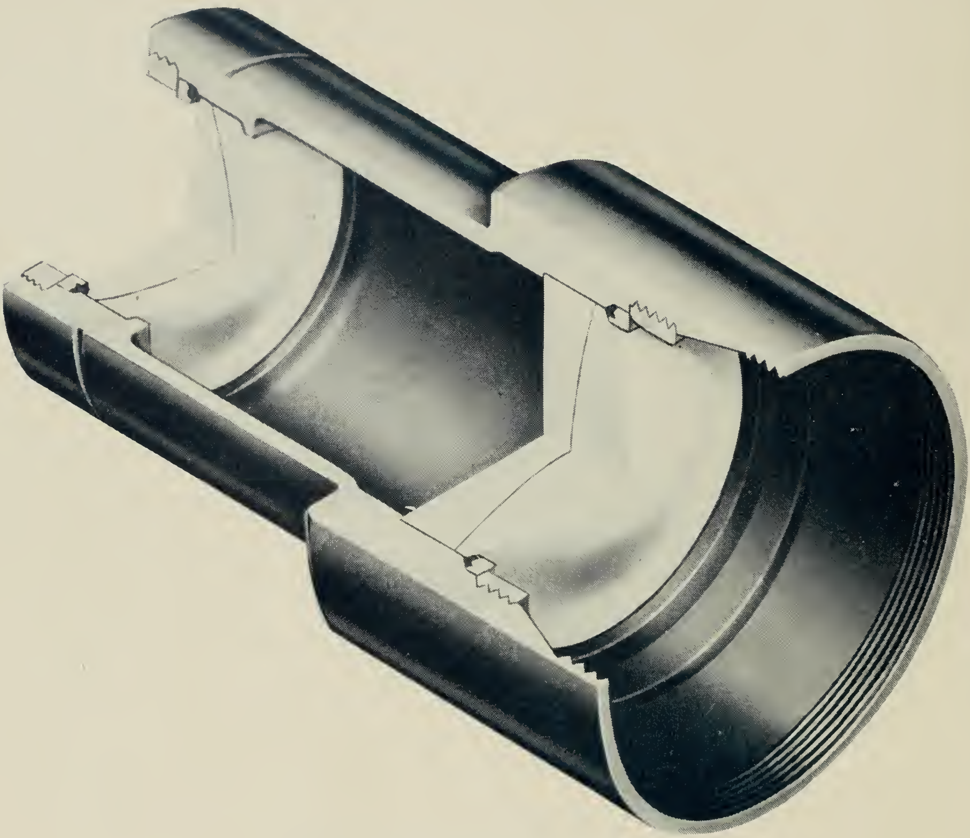
First, the picture must be bright enough to be seen comfortably. Early pictures were shown in almost total darkness, on a small screen, with a short throw. These conditions were almost ideal from the projection standpoint. However, as theatres increased in size, the screen became larger and the level of auditorium illumination was increased. These developments adversely affected screen illumination.

Compensating advances were made, however. More and more powerful arcs were developed, along with the necessary auxiliaries. Screen design showed a marked improvement. Projection lenses meanwhile increased in "speed"; today, lenses as fast as f/2.0 are common. These "fast" lenses increase screen brilliance by utilizing virtually every ray of light passing through the aperture.

It would appear that the limit has about been reached in this trend toward "faster" projection lenses. Improved condenser systems have increased the concentration of light in the projection lens. Further, a "fast" lens is a large lens—and the space available in existing projectors is limited.

A more spectacular increase in the light transmission of projection lenses results from treating the individual lens elements with an anti-reflection coating. In an untreated lens, about eight percent of the light is lost by reflection at each optical surface.

To prevent this, on each optical surface there is deposited a thin layer of magnesium fluoride of a thickness only one-quarter the wave length of light. The increased light transmission is most noticeable in lenses having several elements—in some lenses, as much as fifty percent of the light is lost by reflection, most of which can be reclaimed by treating each optical surface with an anti-reflection coating. Adoption of coated lenses is the easiest way of putting a brighter picture on the screen, since it involves no extra current, no extra heat, and no extra equipment.



Snaplite Series II—cutaway view.
The Snaplite f 2.0 Series II is a typical four element lens featuring coated lenses, black anodized finish and hermetically sealed mount. It is never necessary to take it apart for cleaning.

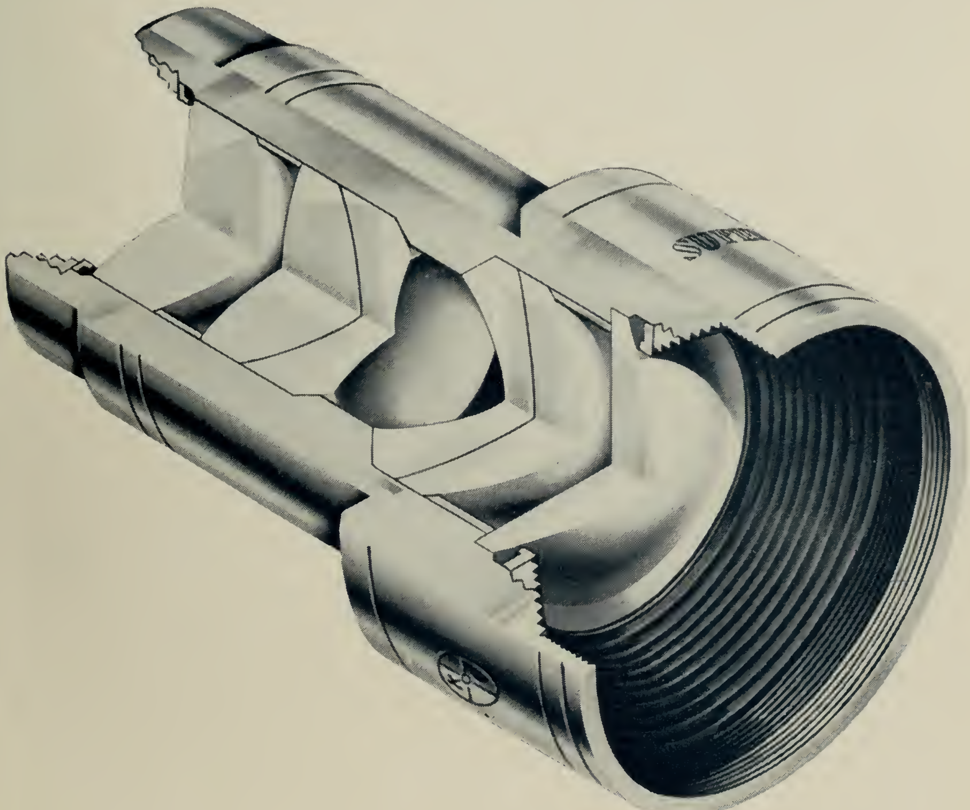
Contrast

Along with brilliant illumination, contrast is an important factor in projecting a picture that is "easy to look at." By contrast is meant a picture with crisp, sparkling highlights and rich, deep shadows free from "grayed-out" or "muddled" effects of spilled light. Here again the anti-reflection coatings used on projection lenses have scored a considerable improvement. By virtually eliminating multiple reflections, these coatings insure that no stray light reaches the screen—at least through the projector lens. It is still desirable to eliminate as

much as possible any stray light falling on the screen from the auditorium, but the increased contrast achieved with coated projection lenses does permit the somewhat higher levels of house illumination currently being favored.

tion, but obviously reduces the light transmission.

Better definition in recent lenses has resulted from more highly developed optical glass, and from added refinements in lens manufacture. Modern projection lenses



Super Snaplite—cutaway view.
The f 1.9 Super Snaplite is the fastest projection lens available. It is a true anastigmat with six elements, anti-reflection, coated, secured in a dust and oil proof hermetically sealed one piece mount.

have sharp enough definition, flatness of field, and freedom from color fringes to satisfy the most critical observer. Needless to say, improvements are still being effected, but there is no longer any excuse for annoying color fringes, or for pictures that are sharp in the center and blurred at the corners.

Definition

Projection lenses differ widely in the matter of definition or image sharpness. Here the lens designer is faced with a dilemma: brilliance vs. definition. A "faster" lens gives a brighter picture but is more difficult to design for good definition. Adding elements to the lens can improve defini-

Distortion

Because of the relatively long focal length lenses used in most theatres, distortion—in the strictly optical sense—has never been a problem in projection lenses. It should be remembered that elongation of the image is caused by high projection angles and not by the projection lens. The same is true of "keystoning", or widening of the picture at the bottom, with its characteristic convergence of vertical lines toward the top of the screen. Longer throws, with longer focal length lenses, and flatter projection angles will overcome these troubles. They can be reduced somewhat by tipping the screen backward, but the effect anywhere but in the center of the house is usually so grotesque that the elongation and keystoning are preferable.

More objectionable "distortion" is often caused by location of seats too far over at the side of the house. Optically speaking, this is not true distortion, but merely the familiar law of perspective. Several screens have been devised in an attempt to compensate for perspective when the screen is viewed from the side. While they may add to the illusion of naturalness (which, of course, is all to the good), they can never circumvent the laws of perspective. The important thing to remember is that this type of "distortion" is not true distortion, but the natural perspective seen when viewing anything obliquely. In any event, all the projection lens can be expected to do is to throw the picture on the screen—a literal image of what is on the film. Image elongation, keystoning, perspective—these are not the fault of any lens, but of the conditions under which it is used.

Picture Size

The picture size is dependent both on the throw and on the focal length of the projection lens. The longer the focal length, the smaller the picture for a given throw. It is for this reason that long throws require long focal length lenses. When using a chart to determine the focal length of lenses, remember that the throw is measured from the screen to the aperture of the projector, and not to the lens itself.

Sometimes, when changing lenses in a projector, the size of the picture changes slightly, although the focal length of the new lens is the same as the old one. The reason is that no focal length is absolutely exact. An undetectable variation at the projector might become noticeable on the screen, particularly if the image with the new lens does not quite fill the screen to the masking.

To avoid this annoyance, Snaplite projection lenses are supplied with the focal length tolerance on the minus side. For instance, if a 5″ Snaplite shows any deviation, it will be, say, 4.983″ focal length. This will give a picture slightly larger than with an exact five inch lens, so no trouble should be experienced in filling the screen.

Life of Lens

It might be expected that the life of the lens is indefinite, since it is made of metal and glass with no moving parts. However, oil, dust, improper cleaning, and breakage during handling all tend to destroy the usefulness of the best lens.

The better type of modern lenses are made in one piece mounts with the optics hermetically sealed in to exclude oil and dust from the interior surfaces. Never attempt to open a sealed lens. It should be returned to the manufacturer for cleaning, adjustment and resealing.

Cleaning and Care

Lenses should be cleaned carefully every day before starting up as part of the regular routine. It is well to remember that the dust particles which accumulate on a lens are frequently harder than the glass itself, and that scratching will result if this dust is rubbed into the lens surface.

The best procedure is to remove the dust first, using a clean camel's hair brush, which should be kept clean and employed for no other purpose. The surface should then be cleaned with lens tissue moistened with a liquid lens cleaner, grain alcohol, or

acetone, and then dried with another piece of clean tissue. Cloths usually contain abrasive particles and should not be used. With proper care, the anti-reflection coatings will last indefinitely.

Lens Mounting

An additional advantage of the one piece lens mounting is that it avoids misalignment between the elements. In the Snaplite Series II and Super Snaplite lens, the mounts are made of high strength aluminum, finished with the Alumilite process. This process imparts a permanent, non-flaking, and non-reflecting finish to the interior of the mount. The aluminum mount has the advantage, because of its lightness, of producing less strain on the lens holder, and consequently less tendency to vibrate or become misaligned.

Accuracy of alignment is essential to good projection. It is important that the light source reflector, condensing system, aperture and lens be held rigidly upon a common axis. Modern projectors provide accurate and sturdy brackets for the lenses with excellent means for focusing. It was formerly necessary to insert lenses in only one position of rotation, but with the modern lens, having optics correctly centered in the mount, this is unnecessary.

A prominent projectionist has said that the best investment in picture quality is a good lens. In many theatres, the comparatively small investment required to replace old and inefficient lenses will pay large dividends in screen quality. In all theatres a common sense daily routine of lens care is needed to keep projection equipment at its maximum efficiency.

"Is there any chance of my ever getting a job with this studio?"
"There may be. I won't live forever."

Maintenance of Older Projectors

Motiograph Model "K"

Many experienced projectionists—whether they are working with the Model "K" or not—are familiar with the operation of the projector, which is perhaps typical of prewar models. While this article on the operation and maintenance of projectors is intended primarily for those most in need of instruction, perhaps even the veteran projectionist may find much that may be of value.

General Specifications

Case and Main Frame. The design of the mechanism is based on a cast iron case and main frame ruggedly constructed.

The Shutter. Motiograph offers in the Model "K" a cylindrical double shutter, located between the light source and the aperture, and operating horizontally. This shutter gives maximum light on the screen with complete absence of "travel ghost" and flicker for the full life of the mechanism, while the shutter rotor reduces the heat at the aperture and tension plate.

The Intermittent Movement. In the Model "K" intermittent movement, every moving part—star, cam, cam pin and sprocket—is made of hardened steel, ground and fitted together precisely. The use of self-lubricating bushings and ball bearings assures silent operation. There are no gears within the intermittent that might develop back lash and cause picture jump.

The Film Path. Studio-type guides and rollers reduce side motion of the film. The film gate is of heavy steel supported at four points by a cast iron back plate. Its rigid construction holds the film in contact with the aperture and in the plane of exact focus at all times. Tension shoes, sprockets and guides are of hardened steel, giving extremely long life to the entire film path.

Framing and Focusing. The Model "K" has dual framing controls, enabling the projectionist to frame from either side of the projector instantly and conveniently. The dual micrometer type focusing control knobs are also accessible from either side. A quarter turn of either focusing knob moves the lens less than eight-thousandths of an inch, eliminating the possibility of running through the point of focus with modern high speed lenses.

The Gear Train. All of the steel gears and shafts in the Motiograph "K" are hardened and ground to micrometric accuracy, making for long gear life and extremely low maintenance cost. Every shaft is provided with a removable self lubricating bushing, which renders shaft replacement virtually unnecessary for the entire lifetime of the projector.

Fig. 1. The Motiograph Model "K"

Threading the Projector

As every type of projector is threaded in a slightly different manner, the projectionist will have to learn about the machines he must handle. Threading the Model "K" is easy to learn and easy to do.

Here is the correct way to thread a Motiograph (see Figs. 7 and 8):

1. Adjust the framing device so that the arrows on the film track support and the lens barrel correspond.

2. Open the doors of the upper and lower magazines, the mechanism, the sound head, and the rear gate of the mechanism.

3. Place the guide rollers of the mechanism and the sound head in open position.

4. Set the timing of the intermittent sprocket. This is accomplished by turning the mechanism (employing the various means provided on the sound head) to the point where the intermittent sprocket is about to turn.

5. Put the reel in the upper magazine and lock the reel-latch, pull down the film until the leader is just above the floor, and insert the film in the fire-trap rollers.

6. Close the upper magazine door. (This is important—it removes a fire hazard).

7. Thread the film over the upper feed sprocket. Close the guide roller.

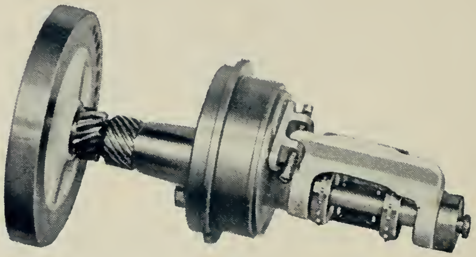


Fig. 3. The Model "K" intermittent movement

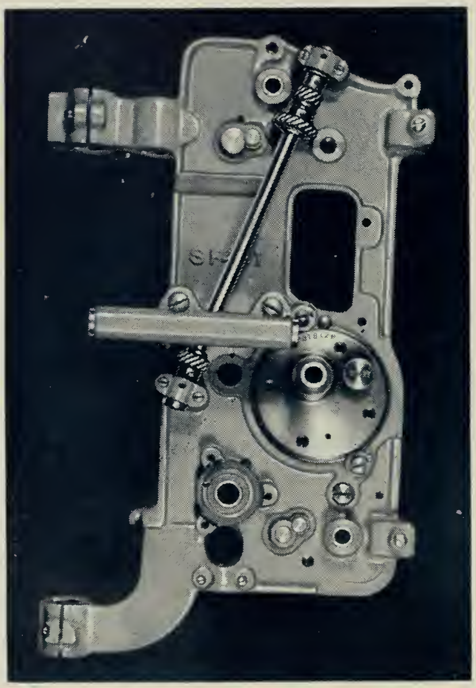


Fig. 2. Main frame of the Model "K"

8. Grasp the film with the thumb and forefinger of the right hand about four inches below the upper feed sprocket, and place the film in the studio guides. Simultaneously, grasp the film with the left hand at a point immediately below the intermittent sprocket, and then place the film in frame at the aperture, allowing about four inches of slack film to form the upper loop. Hold the film over the intermittent sprocket, then close the rear gate with the thumb of the left hand. (Fig. 7).

9. Make about a four inch loop (the size of the loop will sometimes vary a frame or so, depending upon the sound head used), and place the film under the lower guide roller and over the lower feed sprocket (Fig. 8).

10. Thread the sound head and insert the film in the lower magazine. Close all the doors.

11. Run the mechanism to the proper starting point on the film. Stop it at that point, and you are all ready to go when

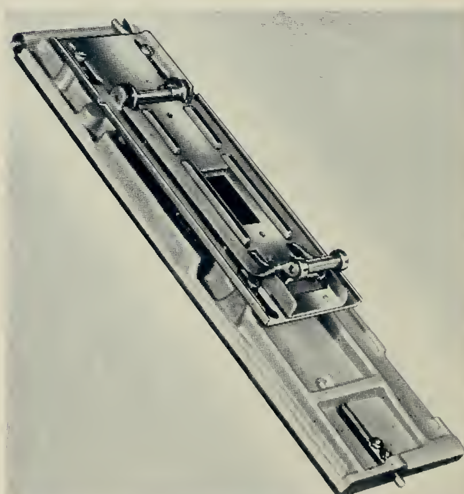


Fig. 4. The film gate and the cast iron back plate

the changeover is to be made.

Timing the Shutter

The shutter is in definite working arrangement with the "heart of the projector"—the intermittent movement. If the shutter is not in time with the intermittent movement, the picture on the screen will show "travel ghost," and consequently blurry pictures.

The shutter is timed perfectly with the intermittent movement, but should the necessity of adjustment arise, the Motiograph, unlike most mechanisms, has provision for two separate methods. No special tools are required to make either adjustment.

Fine shutter timing adjustments can be made with the projector in operation. Loosen the clamp handle on the shutter drive shaft bearing assembly (Fig. 20).

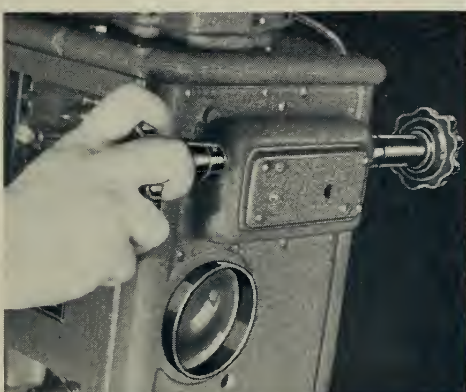


Fig. 5. Framing controls are convenient from either side of the projector

Turn the knurled timing knob on the gear side of the shutter housing as required for perfect timing, then tighten the clamp handle firmly. (In earlier production of the Model "K" the timing knob was located on the operating side of the mechanism).

The adjustment mentioned above is usually sufficient to take care of all the timing adjustments that need to be made.

In a few cases, most frequently after the removal and subsequent replacement of the intermittent movement, the following adjustment would be necessary (See Fig. 11):

1. Remove the cover over the shutter gears.

2. While holding the shutter blades firmly to prevent turning, loosen the cap

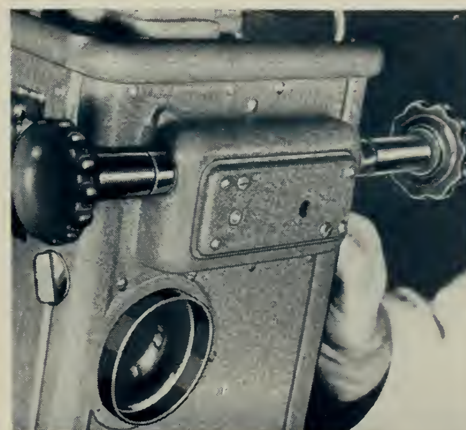


Fig. 6. The dual micrometer type focusing control is also easily accessible

nut on the bakelite pinion gear with about one turn. Pull the bakelite pinion gear out slightly to disengage it from its locking ratchet. This operation frees the blades from the bakelite pinion gear.

3. Center the steel gear directly under the bakelite pinion gear with the fine shutter timing adjustment, so that the adjustment will be in the middle of travel.

4. Turn the projector in the direction of film travel until the intermittent sprocket just begins to move.

5. Set the leading edge of one shutter blade exactly even with the indicating points on either side of the rear opening of the shutter housing.

6. Hold the shutter blades firmly in this position while the cap nut is tightened to lock the bakelite pinion gear into its ratchet

on the shutter shaft.

The shutter should now be in time with the intermittent movement. Any further slight adjustment that might be required can be made when the mechanism is in motion with the fine timing adjustment previously described.

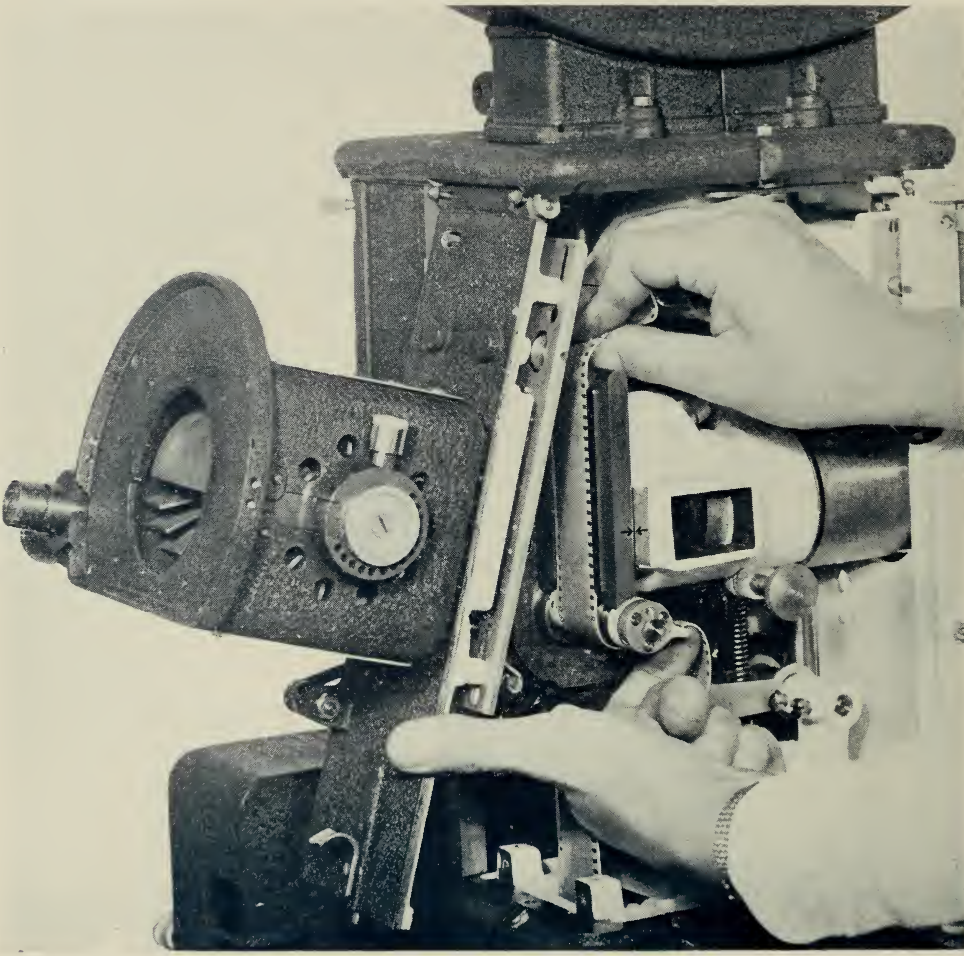


Fig. 7. Threading the Model "K"

Shutter Drive Gear Adjustment

The shutter gear trains on all mechanisms will show wear over a period of time, thus creating lost motion in the gear train which invariably causes "travel ghost" on the screen. Some projector manufacturers make provision to eliminate "travel ghost" by widening the blades of the shutter, which removes the difficulty, but causes an appreciable loss of screen illumination.

The Motiograph cylindrical double shutter was designed to give the greatest pos-

sible amount of light on the screen. Any lost motion that might develop because of worn shutter gears can be eliminated without changing the width of the shutter blades. This adjustment not only causes

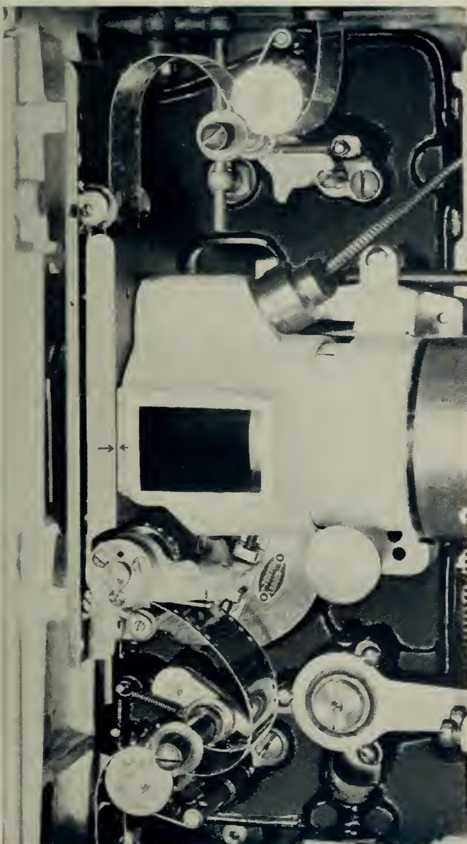


Fig. 8. The Model "K" mechanism, showing proper threading

no loss of illumination on the screen, but eliminates the necessity for annual replacement of shutter gears.

When the shutter drive gears have worn sufficiently to require attention, they may be adjusted in the following manner:

1. Loosen the set screw in the collar on the near end of the shutter drive shaft, and unscrew the collar and the fibre washer from the shaft.

2. Scratch a reference mark across the end of the shaft bushing (an eccentric bushing) and the steel sleeve which holds it.

3. With the blade of a small screw driver, pry the bushing out of the steel sleeve far enough to free its teeth (Fig. 12).

4. Turn the bushing one notch in a clockwise direction, which will raise the drive shaft and the steel gear.

5. Restore the bushing to its normal position with the reference mark one notch away from its original location.

6. Replace the drive shaft collar and its fibre washer. See that the end play of the shaft is approximately 1/64th of an inch before tightening the collar set screw.

Operate the projector with light until the shutter mechanism is thoroughly warm, and then observe the shutter gear action. If it appears that more than a one notch correction of the gear mesh is needed, repeat the operations just described. Never change the mesh more than one notch at a time, as rapid wear and noisy shutter op-

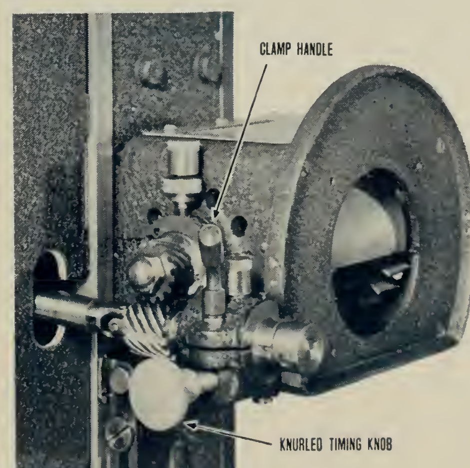
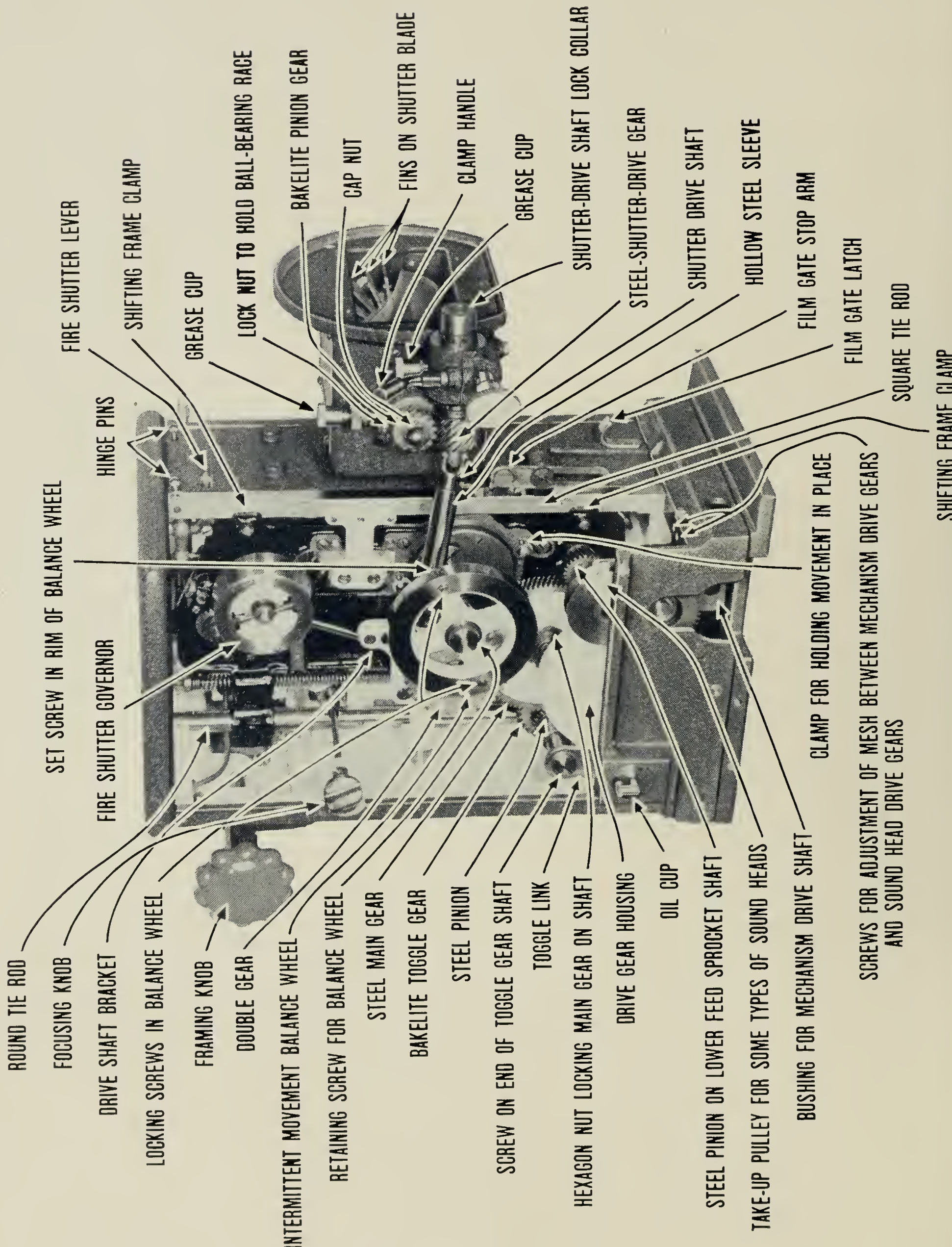


Fig. 9. Fine shutter timing adjustments can be made with the projector in operation


FIRE SHUTTER LEVER
SHIFTING FRAME CLAMP
GREASE CUP
LOCK NUT TO HOLD BALL-BEARING RACE
BAKELITE PINION GEAR
CAP NUT
FINS ON SHUTTER BLADE
CLAMP HANDLE
GREASE CUP
SHUTTER-DRIVE SHAFT LOCK COLLAR
STEEL-SHUTTER-DRIVE GEAR
SHUTTER DRIVE SHAFT
HOLLOW STEEL SLEEVE
FILM GATE STOP ARM
FILM GATE LATCH
SQUARE TIE ROD
SHIFTING FRAME CLAMP
HINGE PINS
SET SCREW IN RIM OF BALANCE WHEEL
FIRE SHUTTER GOVERNOR
CLAMP FOR HOLDING MOVEMENT IN PLACE
SCREWS FOR ADJUSTMENT OF MESH BETWEEN MECHANISM DRIVE GEARS
AND SOUND HEAD DRIVE GEARS
ROUND TIE ROD
FOCUSING KNOB
DRIVE SHAFT BRACKET
LOCKING SCREWS IN BALANCE WHEEL
FRAMING KNOB
DOUBLE GEAR
INTERMITTENT MOVEMENT BALANCE WHEEL
RETAINING SCREW FOR BALANCE WHEEL
STEEL MAIN GEAR
BAKELITE TOGGLE GEAR
STEEL PINION
SCREW ON END OF TOGGLE GEAR SHAFT
TOGGLE LINK
HEXAGON NUT LOCKING MAIN GEAR ON SHAFT
DRIVE GEAR HOUSING
OIL CUP
STEEL PINION ON LOWER FEED SPROCKET SHAFT
TAKE-UP PULLEY FOR SOME TYPES OF SOUND HEADS
BUSHING FOR MECHANISM DRIVE SHAFT

eration will occur if the gears are meshed too tightly.

Removing the Shutter Assembly

While it is seldom necessary to remove the shutter assembly, any such removal is accomplished in the following manner (see Fig. 13):

1. Remove the lock nut, the flat head screw, the sliding washer and the lock washer from the film gate stop arm (see Fig. 9).

2. Pinch together the two hinge pins at the top of the gate. Lift up the latch at the bottom of the gate, and bring the entire gate assembly back to the lamphouse.

3. Move the assembly slightly toward the operating side of the projector, thus disengaging the gate slide link.

4. Pull the shutter drive shaft out of its hollow sleeve (Fig. 13). To remove the shutter housing from the gate, take out the four screws in the inside corners of the shutter housing which attach the housing

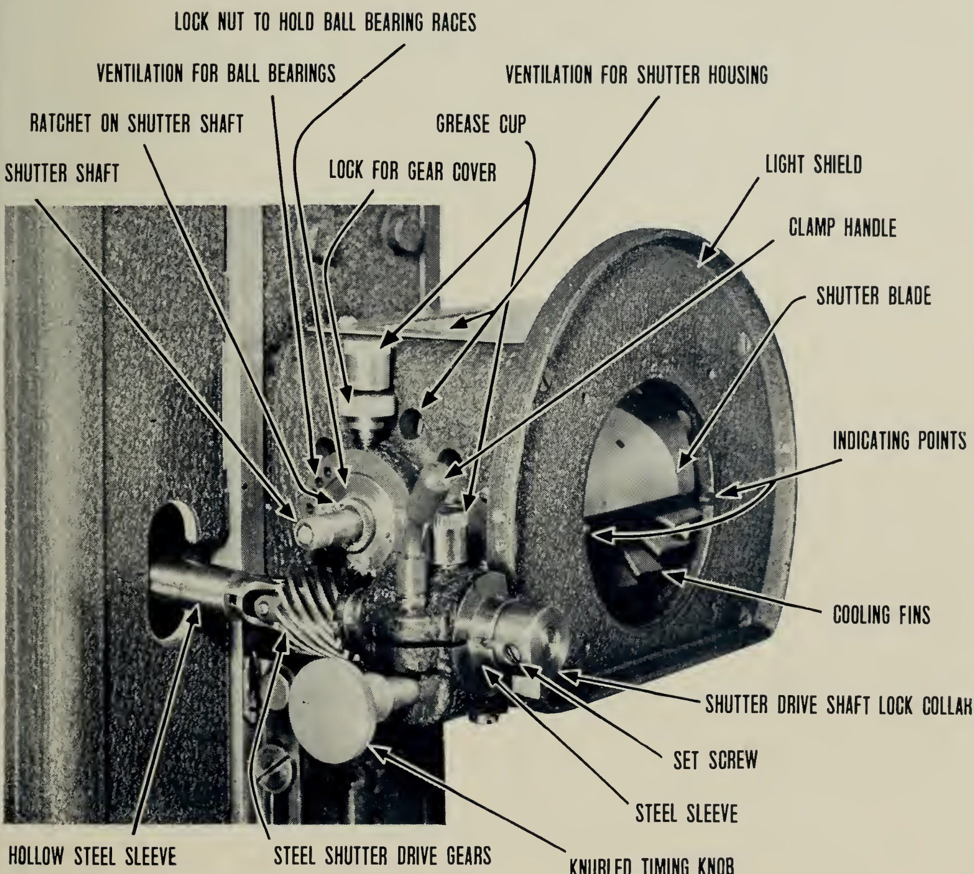


Fig. 11. Shutter drive assembly, with gear cover and bakelite pinion gear removed

to the gate.

Follow this procedure to replace the film gate and shutter assembly:

1. Attach the shutter housing to the rear gate with the four screws.

2. Make certain the fire shutter is closed.

3. Hold the gate assembly in normal open position, engaging the gate slide link in the lug on the slide.

4. Place the top of the gate between the hinge pin bearings, seeing that the yoke of the fire shutter lever engages the working link on the mechanism.

5. Pinch the two hinge pins together, and slip the gate into position.

6. Insert the shutter drive shaft into the hollow drive shaft.

7. Turn the projector by hand until the key in the hollow drive shaft engages with the key slot of the shutter drive shaft.

8. Replace the lock nut, the flat head screw, the sliding washer and the lock washer in the stop arm.

Before operating, be certain that the hinge pins are properly seated.

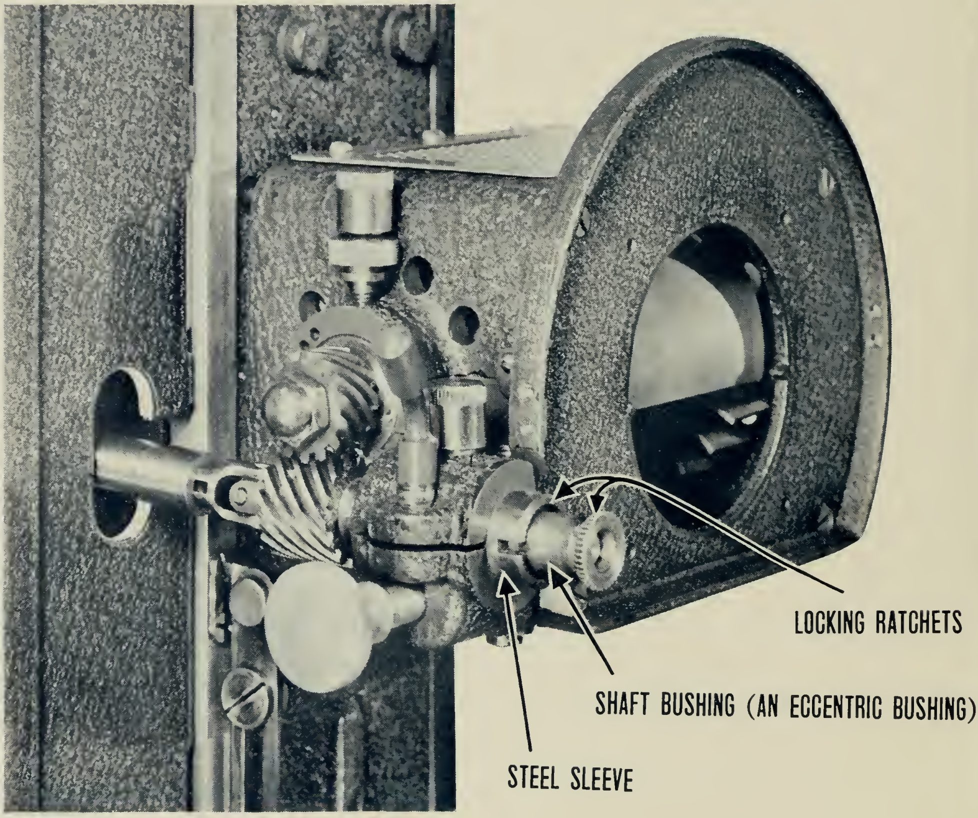


Fig. 12. Photo-diagram for adjustment of shutter gears

Adjustment of Pilot Lamp Switch

The pilot lamp switch housing is provided with slotted mounting lugs. If the

switch fails to operate due to wear of the switch plunger, loosen the mounting screws located at the top and the bottom of the switch housing, and set the housing of the guide roller bracket, however, will probably require adjustment a few times. This adjustment is made as follows (see Fig. 14):

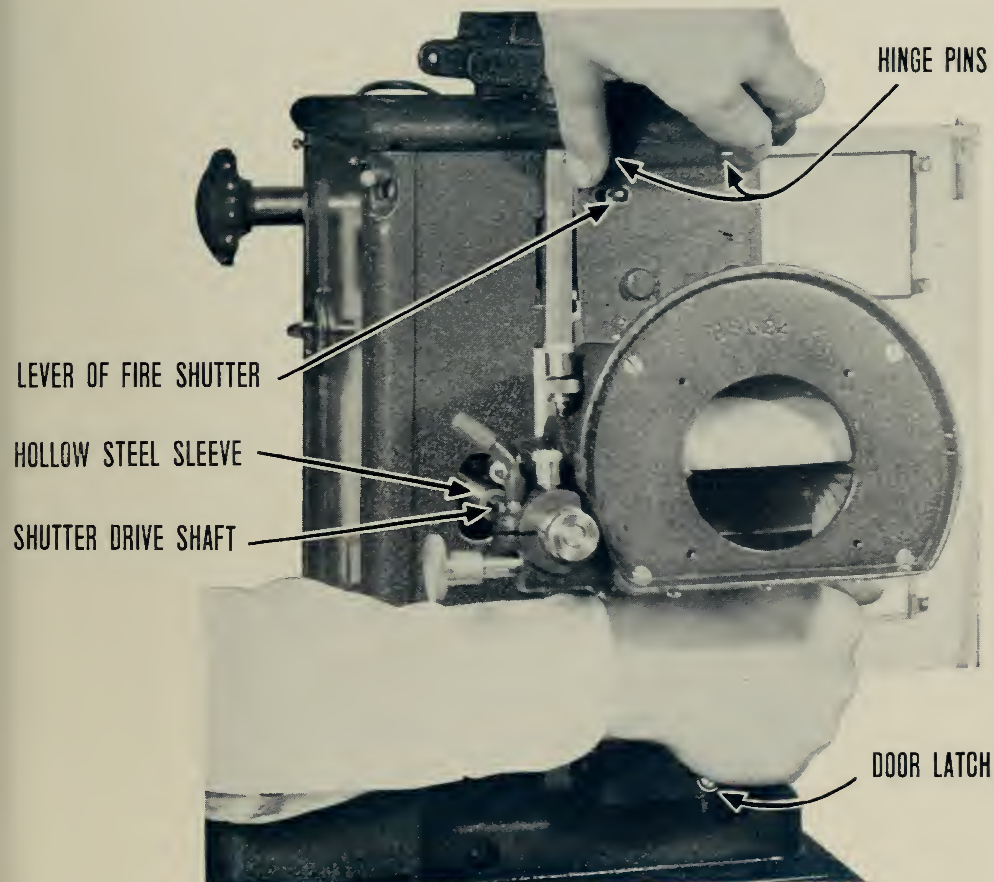


Fig. 13. Removing the shutter assembly

until proper operation is established.

Adjustment of Film Guide Rollers

The guide rollers of the Motiograph Model "K" are made of case hardened steel. If they are kept properly cleaned and lubricated, they should wear for the life of the projector mechanism. The travel

1. Place the guide roller in its closed position.

2. Loosen the clamp screw located directly to the right of the stop pin.

3. Turn the stop pin with a screw driver until the clearance between the roller and the sprocket flange is equal to twice film thickness.

4. Tighten the clamp screw securely.

Adjustment of Sliding Frame Tension

Over a period of time a slight amount of wear may occur in the square and round tie rods upon which the shifting frame travels. Any such wear will cause vibration in the shifting frame, and an unsteady picture on the screen.

There will never be occasion for the replacement of either tie rod, but it may be found necessary from time to time to adjust the shifting frame clamps that slide on the tie rods. The tension of the four clamps on the tie rods should be equal, and great enough to prevent vibration of the shifting frame without making framing excessively difficult.

The screws for the clamps on the square tie rod may be reached from the gear side of the mechanism (Fig. 15). Holes are provided in the front of the mechanism for reaching the screws for the clamps on the round tie rod. Turn the framing knobs as required to make the clamp screws align with these holes.

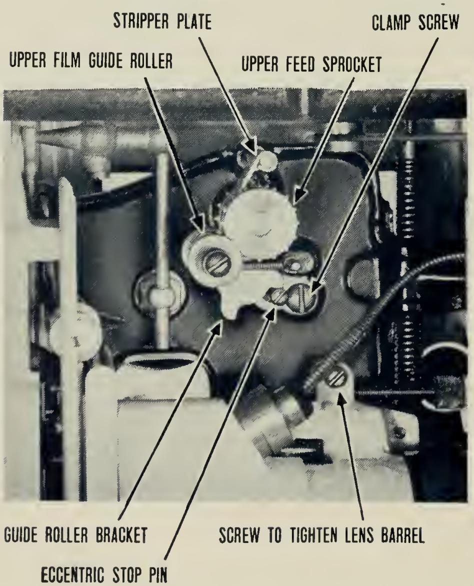


Fig. 14. Adjustment of the film guide rollers

Meshing Projector Drive and Sound Head Gears

Another feature with Motiograph is an adjustment to mesh properly the projector drive gears with the sound head drive gears without the necessity of using shims.

This adjustment consists of two screws set into the mechanism base casting under the left rear half door (Fig. 15). Removal of the door exposes these screws to view. The outside headed screw is tapped into the drive gear housing; the headless screw is tapped into the mechanism base casting so that it acts as a stop for the allowable up or down movement of the gear housing produced by adjustment of the headed screw. Correct gear mesh is established by loosening both screws several turns so that the gear housing can be properly positioned with respect to the sound head drive gear. The headed screw is then tightened until it is just seated, and the headless cock screw is then tightened against the gear housing to lock it rigidly in place, as it must be for normal operation.

When the Model "K" mechanism is used with the Motiograph SH-7500 or the Northern Electric TA-7500 sound reproducer, the drive gear adjustment should be approximately in the middle of its travel in order to allow sufficient slack in the link chain connecting the reproducer and the mechanism.

Removing Toggle Gear and Pinion

The Model "K" has in its bakelite toggle gear an unusual and most satisfactory arrangement to prevent a possible bind-up from stripping the entire gear trains of the projector mechanism and the sound head. While the possibility of a bind-up is remote, if it should happen this gear will strip and thus prevent the stripping of any other gear in the mechanism or the sound head.

To remove the bakelite toggle gear and

pinion, follow these instructions:

1. Remove the screw on the end of the toggle shaft, which is located in the lower left corner of the mechanism on its gear

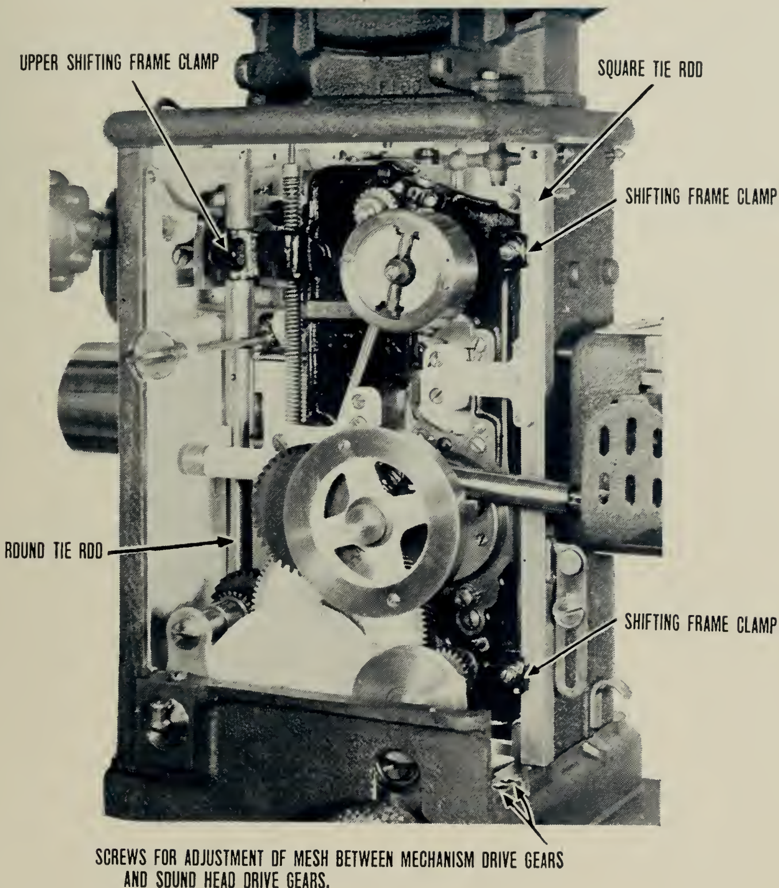


Fig. 15. Gear side of mechanism, showing tie rods and adjustment of mesh between mechanism and sound head gears

side (Fig. 16).

2. Push down the toggle link to the right.

3. On the operating side of the mechanism, loosen the two screws on the toggle casting (Fig. 17).

4. Push the toggle shaft and gears out toward the gear side.

The replacement of the bakelite toggle gear and pinion is accomplished by the reversal of these instructions.

Removing the Film Track Assembly

The film tracks may be cleaned without removing the assembly from the mechanism. The assembly need be removed only

when it is necessary to replace worn tracks. When occasion arises, the removal of this unit is very simple, as the following instructions will indicate.

The film track assembly is held in position by four screws located to the right of and above the intermittent movement on the gear side of the projector (Fig. 18). Upon the removal of these screws, the entire track assembly may be taken out from the operating side of the projector.

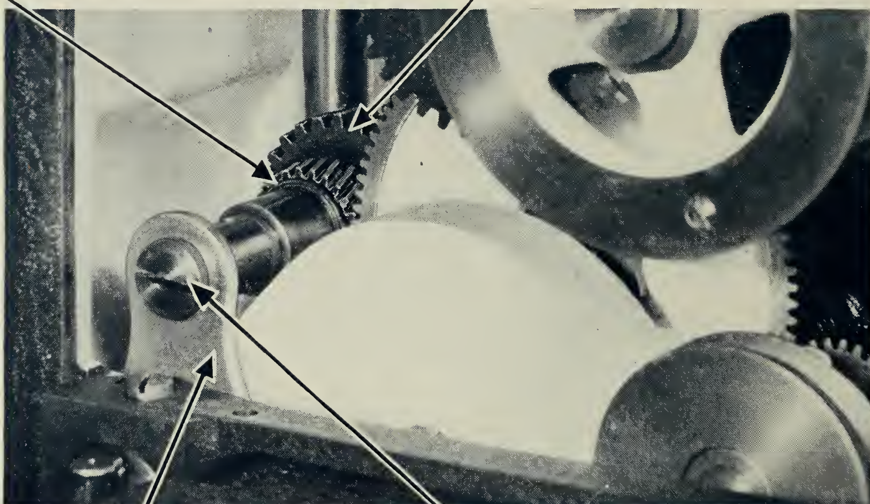


Fig. 16. Bakelite toggle gear, designed to prevent stripping of entire gear trains

Removing the Intermittent Movement

The Motiograph intermittent movement is so well constructed and assembled that there is no necessity for any so-called "easy" removal. On the few occasions when repair is indicated, the projectionist will find that the intermittent movement may be removed without difficulty. This is done as follows (see Figs. 18 and 19).

1. Remove the gear side door and the left half of the rear door.

2. Frame the mechanism all the way up.

3. Loosen the set screw on the lower feed-sprocket stripper-plate shaft, and turn the stripper plate downward until it clears the sprocket.

4. Loosen the set screw holding the pinion gear on the lower feed-sprocket shaft, push the shaft toward the operating side, and remove its pinion gear.

5. Remove the large nut on the main drive gear shaft. (This nut has a left hand

thread.)

6. Remove the main drive gear, pushing the shaft toward the operating side.

7. Remove the two screws in the shutter drive casting, and cock up the drive shaft bracket (see Fig. 19).

8. Loosen the two clamps holding the intermittent movement to the shifting frame. The movement may then be removed by pulling straight out with a slight oscillating motion.

Replacement of the intermittent movement may be made by the reversing of these instructions.

Intermittent Movement Adjustments

The intermittent movement is an extremely delicate mechanism which may be damaged by improper adjustments, and projectionists are therefore cautioned to use the utmost care in this respect. The various adjustments listed below would be required only about once every two or three years in the average theatre. In so-called "grind house" operation, one or more of these minor adjustments may be required in six to nine months.

The projectionist must also bear in mind that the parts expand to some extent when they become heated during operation, and adjustments must not be made so closely as to cause binding in the operation of the movement.

1. Sprocket shaft end play adjustment (Fig. 20).

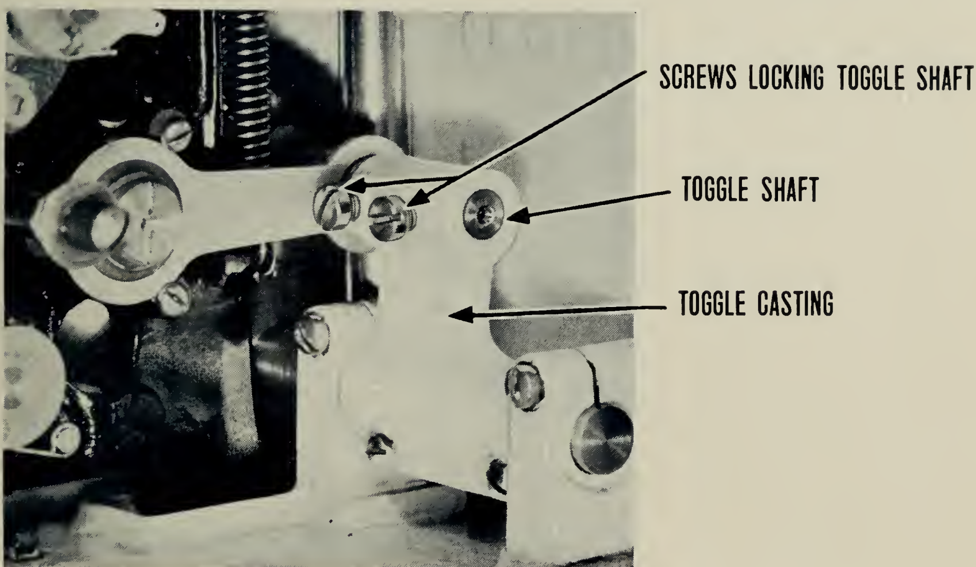


Fig. 17. Toggle casting

Loosen the adjusting pin set screw in the collar on the outer end of the sprocket shaft. Press very gently inward on the knurled end thrust adjusting pin to take up the end play. Tighten the set screw.

2. Cam shaft end play adjustment.

First loosen the two locking screws in the face of the balance wheel, and then loosen the two set screws in the rim of the balance wheel. With a screw driver pry the knurled knob outward, which will automatically press the balance wheel inward and thus take out the end play. Then

tighten the rim set screws and the locking screws in the face of the balance wheel.

3. Star and cam adjustment.

This adjustment should not be attempted without first removing the movement from the mechanism. Hold the movement in one hand, and turn the balance wheel until the sprocket is in about the middle of its rest period. With the fingers on the sprocket, feel the amount of play between the cam and the star. To remove this play, turn the two adjusting screws in the direction shown on the indicator plate to bring star and cam closer together. In a correctly adjusted movement, the sprocket is held firmly in its rest position, while the movement feels smooth and free as the balance wheel is rotated in its proper direction by hand.

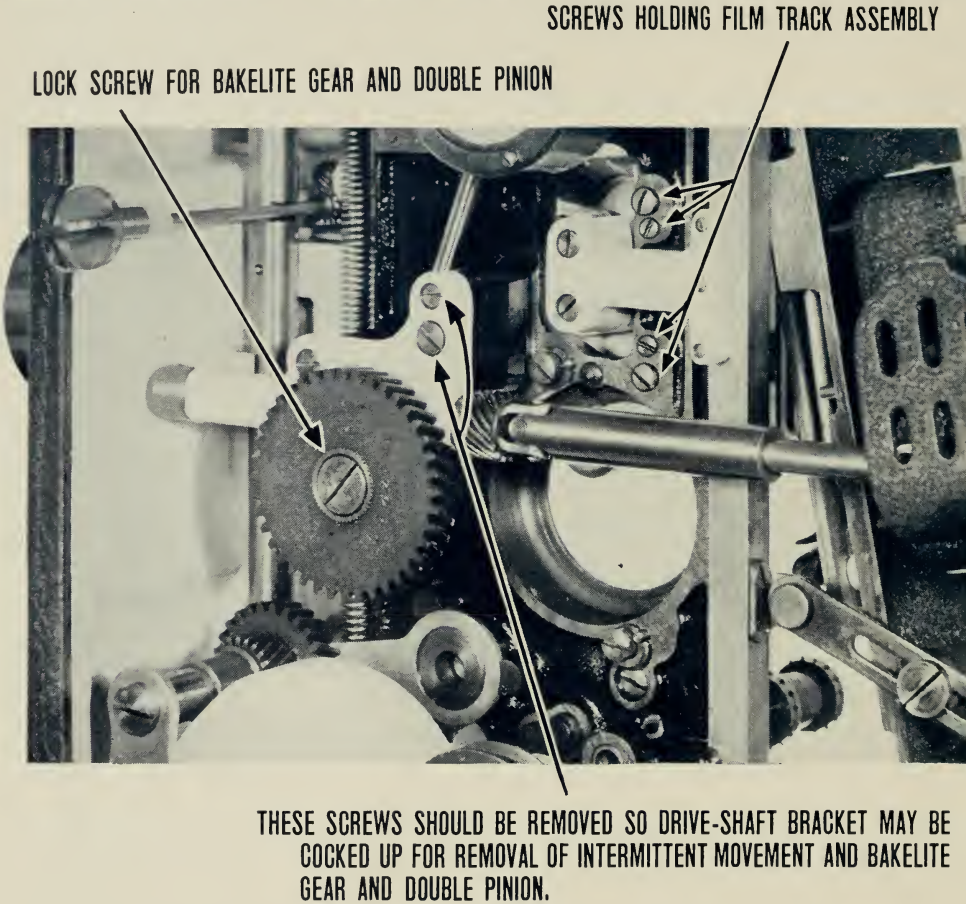


Fig. 18. Gear side of mechanism, with intermittent movement removed

Removing Bakelite Gear and Double Pinion

The following instructions are rather superfluous, inasmuch as it is highly im-

probable that the bakelite gear and double pinion will require replacement more than once in the projector's lifetime. They are given, however, in order to make this description complete (see Fig. 18):

1. Remove the intermittent movement.
2. The bakelite gear and double pinion are held in place by one lock screw on the end of the shaft. The gear and pinion assembly may be removed by taking out this screw.

Replacement is accomplished by the reversal of these instructions.

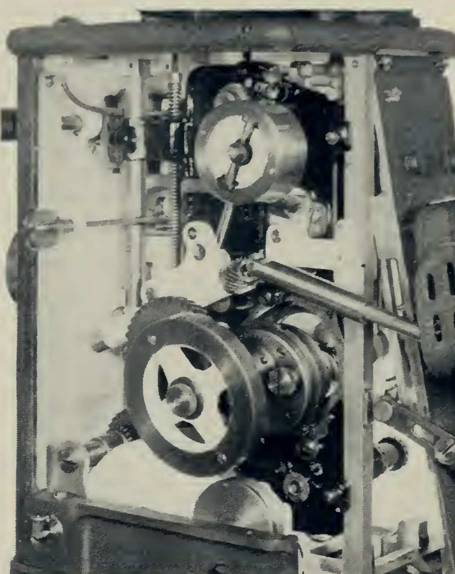


Fig. 19. Gear side of the Model "K" showing intermittent movement in process of removal

Takeup Maintenance

The lower magazine of the Motiograph Model "K" is equipped with a friction cone-type takeup requiring little attention (Fig. 21). The bearings should be lubricated daily with a few drops of Motiograph Mechanism Oil, and the cork cone face should be lubricated by applying about two drops of oil per week to the hole in the cone support.

Tension is adjusted by the large knurled nut on the spindle shaft. Correct tension is that which will slowly accelerate from rest a fully loaded reel of the largest size normally used. When the tension is prop-

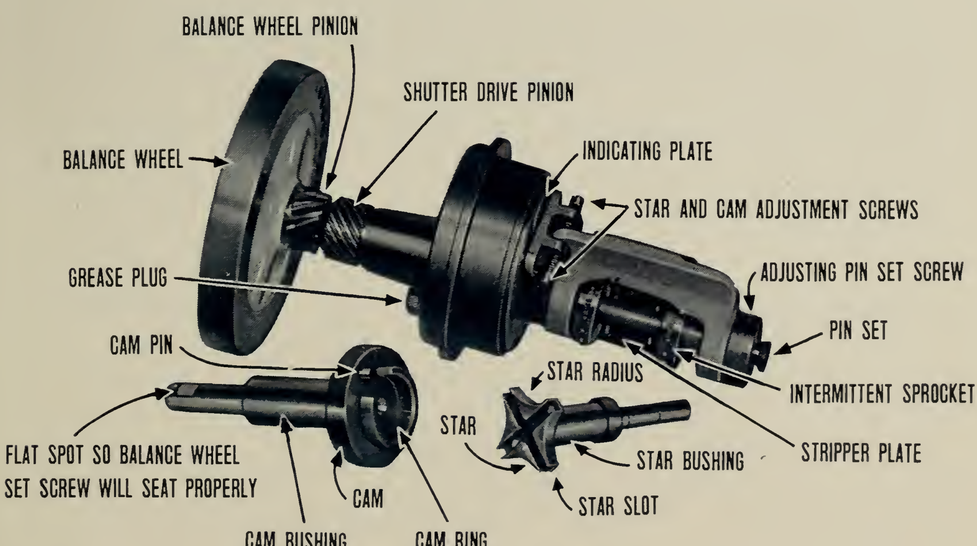


Fig. 20. Photo-diagram of intermittent movement

erly set, the lock nut on the spindle shaft should be tightened against the knurled adjusting nut.

Irregular or jerky takeup action is evidence of improper tension adjustment, or indicates that cleaning is needed. After disassembly, the parts should be washed in carbon tetrachloride or some other suitable solvent, and the dirt and grit scrubbed from the face of the cork gripping disc. After the parts are clean and dry, soak the cork disc in mechanism oil, rub a little graphite on the cork, and reassemble and adjust the takeup.

• • •

Too much tension on the takeup is tough on sprocket holes and sprockets. How long is it since you have checked your takeups?

Where old films are being run, the fire trap rollers in your magazines should be examined and cleaned each day.

• • •

Watch sprocket teeth and replace them at once if they show signs of hooking or undercutting.

• • •

If you are operating a mechanism using the oil-bath principle, be sure that the oil is changed regularly, for foreign matter can accumulate in the oil which may cause much damage to gears and shafts. Use the oil recommended by the projector manufacturer.

• • •

The over-oiling of a projector is nearly as bad as no oil at all. Wipe off all excess oil after you lubricate your projector.

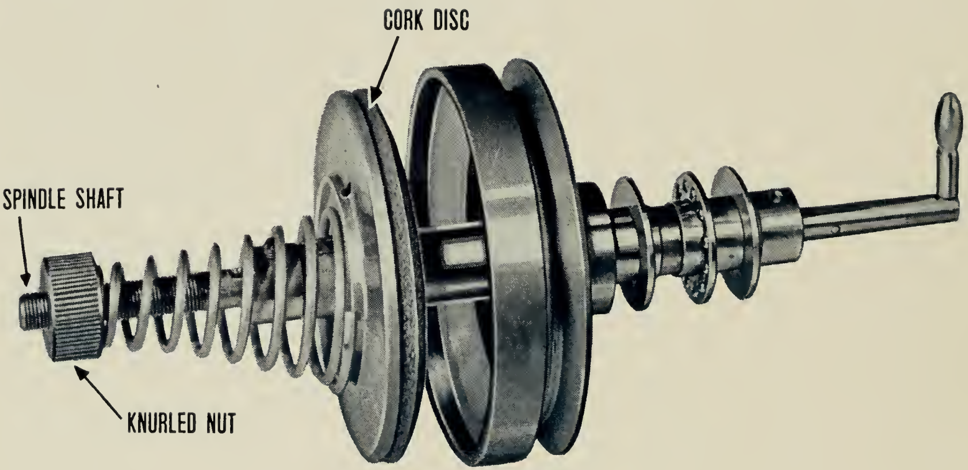


Fig. 21. Friction cone-type takeup of lower magazine

Modern Projector Maintenance

The Model "AA"—a Postwar Type

The Motiograph "AA" may be expected to give flawless screen performance for its entire lifetime with an absolute minimum of care and adjustment, and it should run for years before any part replacements are indicated.

The "AA" mechanism is of unit construction, and thus it is possible to replace any unit without removing the mechanism from the sound reproducer. All units can be removed so easily and quickly that the entire mechanism may be taken apart in a matter of minutes instead of hours. Replacement of any unit can also be made quickly, and as it can be put back into place in one way only, it is impossible to reassemble the mechanism incorrectly.

The tools required to completely disassemble the "AA" are six Allen wrenches, which are supplied with the "AA." (These can be replaced at any hardware or automotive supply store in the event of loss.) No wrenches, hammers, pin-pushers, broaches, reamers, or special tools are needed to take out and subsequently replace any unit of the "AA."

Care of the "AA"

The only daily care required is the dusting and cleaning of lens, shoes, tracks and aperture.

The projection lens can be removed by turning the "lens-lock" control at the front of the mechanism (Item 18, Fig. 1) several turns counter clockwise. The stop (Item 13, Fig. 1) is set during original positioning of the lens in the carriage, so that after cleaning, the lens can be returned to its position of exact focus.

The film gate of the "AA" opens one full inch, which makes it possible to clean the shoes, tracks and aperture without removing any of these units. When more careful cleaning is indicated, the aperture and tracks (which are one integral unit), and the tension shoes (again one unit) can be easily and quickly removed and replaced.

Projectionists, knowing how difficult it is to remove the fire-trap rollers in most upper magazines, will be glad to learn that the fire-trap rollers in the "AA" upper magazine can be removed for cleaning and replaced in a few minutes without removing the magazine from the mechanism. As much film damage originates from dirty, sticking or faulty fire-trap rollers, Motiograph has eliminated a source of film mutilation. The cleaning operations outlined, along with semi-annual lubrication in a few spots, are all the tasks that the projectionist is required to perform to keep his Motiograph "AA's" operating at peak performance. As the following diagrams and instructions will show, it is easy to make any adjustments and replacements that might be indicated when wear ultimately comes.

The Motiograph "AA" projector mechanism can replace nearly any make and

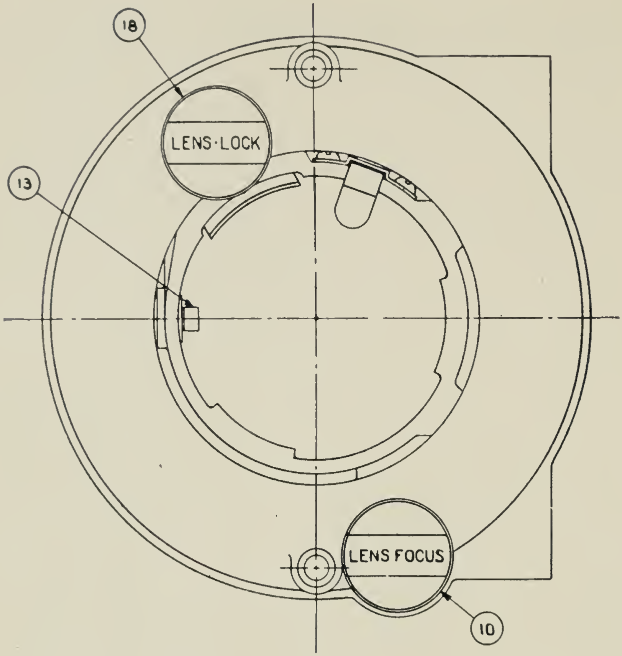


Fig. 1. Front view of lens carriage

Item 10. Lens focusing knob

Item 13. Lens barrel stop

Item 18. Lens lock control

model of projector mechanism on any sound reproducer without the use of mechanism plates or adapters, and the same projector-sound reproducer driving apparatus may also be used. (Exceptions are that the "AA," like all other modern projectors, is not interchangeable with the Powers or with the Motiograph "F," "H" and "HU" projectors, unless different projector-sound reproducer driving apparatus is obtained from the manufacturer of the sound reproducer.)

To install the "AA," remove the framing knob and covers on the gear side of the mechanism. The mechanism may then be fastened to the sound reproducer with the machine screws furnished. Most modern sound reproducers require the use of two 3/8″-16x3/4″ cap screws installed from the sound reproducer into the mechanism base. With some sound reproducers, a shorter 3/8″-16x7/16″ cap screw is required in a hole nearest to the front of the mechanism so that the screw does not strike the lower gear of the mechanism. Certain older soundheads are designed to employ a 5/16″-18x7/16″ F. H. screw inserted through the base of the mechanism into the soundhead. In such cases, the lower feed sprocket drive gear and the steel gear that meshes with the drive pinion must be removed while installing the screw.

The bases of the "AA" mechanisms are carefully machined, as are the tops of most modern soundhead castings, so no shims are usually necessary to obtain proper clearance of projector drive gears when the "AA" mechanism is employed with modern soundheads. When older soundheads with poorly machined castings are employed, some shims may be required between the mechanism and the soundhead.

Remove the projector drive assembly from the mechanism by releasing the clamps on the lower portion of the center frame. The Allen screw (Item 5, Fig. 2), located between the teeth of the steel drive

pinion (Item 4, Fig. 2), and the three Allen screws (Item 2, Fig. 2) located in the socket unit (Item 1, Fig. 2) of the drive assembly, should be released sufficiently to enable the insertion of the soundhead's

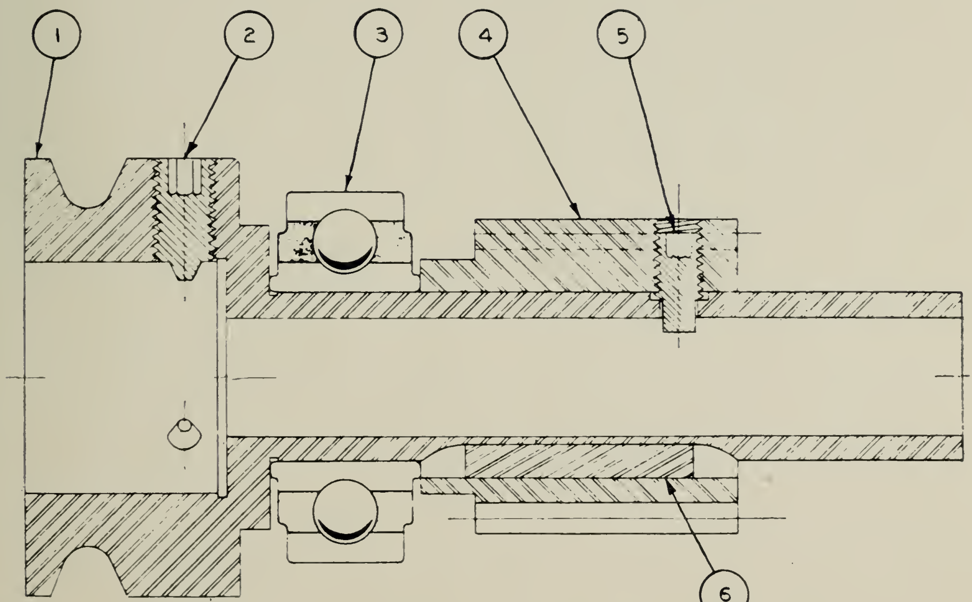


Fig. 2. Projector drive assembly

Item 1. **Socket unit of drive shaft**
Item 2. **Three Allen screws that lock projector drive pinion in place in projector drive assembly**
Item 3. **Ball bearing**
Item 4. **Steel drive pinion**
Item 5. **Allen screw that locks soundhead drive shaft**
Item 6. **Key that locks pinion to shaft**

drive shaft. After insertion of the soundhead's drive shaft, the Allen screw (Item 5, Fig. 2) should be tightened against the flat of the soundhead's drive shaft. The three Allen screws (Item 4, Fig. 2) should be tightened simultaneously into the teeth of the pinion on the drive shaft. The entire projector drive assembly should then be inserted into the mechanism so that its steel drive pinion meshes properly with its associated gear. The clamps should be tightened to hold the entire projector drive assembly rigidly in its proper position. The mechanism should then be turned over by hand to ascertain if the steel drive pinion of the projector drive assembly is in proper engagement with its associated gear.

After the sound reproducer and projector mechanism are coupled together, the covers and framing knob should be replaced.

Motiograph furnishes with its "AA" mechanism a removable fire-trap roller assembly upon which the upper magazine is mounted. When "AA" or other modern upper magazines are to be used, they are

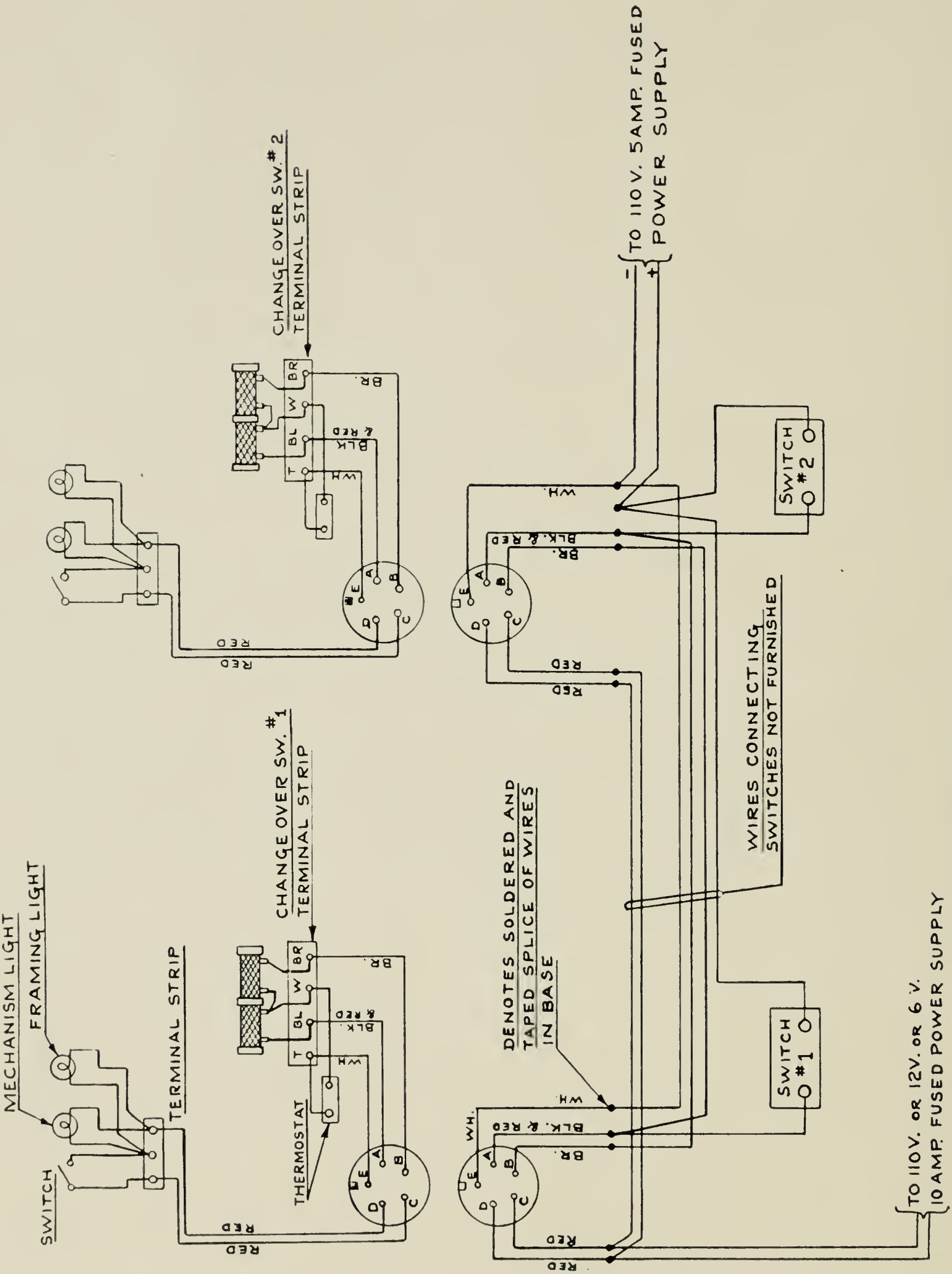


Fig. 3. Wiring diagram of mechanism and changeover switch

easily attached to the fire-trap roller assembly. When Motiograph Model "K" upper magazines are to be used, the fire-trap roller assembly furnished with the "AA" projector mechanism should be removed, as Motiograph Model "K" magazines have an inbuilt fire-trap roller assembly.

Motiograph "AA" lower magazines fasten to the soundhead in the conventional manner. The screws provided should be inserted in the soundhead, and then the lower magazine should be slipped into place, so that the fastening screws will engage the slots on the top of the lower magazine. The screws should then be tightened.

After the necessary connections of take-up and sound reproducer have been made, and before power is turned on, the mechanism should again be turned over by hand to make certain that all connections have been properly made. The "AA" mechanism and magazines will have been properly tested at the factory, but if by chance any adjustments are necessary, they should be effected as hereinafter described.

The wiring of the framing light, mechanism light and changeover is installed in the mechanism at the factory. It is not necessary, therefore, for any wiring to be done inside of the mechanism itself. The wiring diagram (Fig. 3) will clearly show the electrical connections to be made up to the mechanism.

Installing Lens

Open the lens lock on the front of the lens barrel (Item 18, Fig. 1). Loosen the lens stop-lock (Item 13, Fig. 1) on the side of the lens barrel. After getting the exact lens focus, set the lens stop up to the end of the lens jacket and lock it into position. Tighten the lens lock, and the lens will then be in exact position.

Threading

1. Turn the framing handle so that the reference mark on its dial coincides with the "center" indicator marking.
2. Open the doors of the upper and lower magazines, mechanism, and sound reproducer.
3. Open the film gate, separate intermittent sprocket shoe, and the upper and lower pad rollers. The film gate is opened by pushing inward on the large knob just below the lens carriage while turning it clockwise about a half turn. The intermittent sprocket shoe assembly is opened by pushing away from the sprocket the two finger grips until the automatic latch functions.
4. Set the timing of the intermittent sprocket. This is accomplished by turning the mechanism over by hand to the point where the intermittent sprocket just begins to move, indicating that the cam pin is about to engage a star slot. Set the movable indicator cap in the outer intermittent sprocket bearing so that one of the four engraved lines on the cap will be in line with the single line on the locking collar. This will enable the projectionist to know in later threading operations exactly when the cam pin is engaging one of the star slots.
5. Set the variable shoe tension indicator to the desired point, "LOW," "STD," or "HIGH." (See Fig. 2.) The "LOW" position provides a film tension of about 225 grams, suitable for new, green film. The tension in the "STD" position is approximately 375 grams, which is correct for film in average condition. The "HIGH" position increases the tension to around 675 grams to aid in flattening badly buckled older films.
6. Put the reel in the upper magazine and lock the reel latch. Pull down the film until the leader is just above the floor, and insert the film in the upper fire-trap rollers.
7. Close the upper magazine door. (This is important—it removes a fire hazard.)

8. Thread the film between the film guide roller and the upper feed sprocket.
9. Grasp the film with the thumb and fore-finger of the left hand about four inches below the upper feed sprocket, and place the film on the two pins on each side of the lighted framing aperture so that the picture is in exact frame.
10. While holding the film in place over the framing aperture, place the film in the film gate and over the intermittent sprocket; then close the intermittent sprocket shoe by pressing its actuating button. Press inward the large gate control knob to release its latch and thus close the film gate. The film, when released, will come up from the pins on the framing aperture and form the correct upper loop. Then close the upper pad roller. (When the film is placed in frame upon the framing aperture, it will automatically be in correct frame at the picture aperture.)
11. Make about a four inch lower loop and place the film under the lower pad rollers and over the lower feed sprocket and thence down to the soundhead. Close the pad rollers.
12. Thread the soundhead and insert the film into the lower magazine. Close all doors.
13. Run the mechanism to the proper starting point on the film, stop it at that point, and you are all ready to go.

Lubrication

Lubrication of the "AA" mechanism is no problem.

All gears and shafts run on grease-packed ball bearings which require no further lubrication for their long lifetime.

Grease-packed ball bearings are also used on both the star and cam shafts of the intermittent movement. The intermittent movement housing is equipped with a large grease reservoir which provides lubrication for the meshing of the cam pin and the star slots. The amount of grease in the movement reservoir will be more than sufficient to last six months under average projection conditions. The grease level should be checked periodically, and more grease inserted if necessary. To grease, merely remove the plug in the face of the movement housing (Item 5, Fig. 4) and use the grease gun provided, bringing the grease up to its proper level. (If an oversupply of grease is inserted, the surplus will come out of the vent on the gear side of the mechanism.)

Later movements have two plugs. The second one, located below and to the left of the intermittent sprocket, serves as a grease level indicator. In filling these movements, remove both plugs and fill through the upper hole until the grease begins to pour from the lower hole.

The upper guide roller (Item 1, Fig. 4) and the film guide rollers (Items 3 and 4, Fig. 4) will probably require semi-annual filling of the grease reservoirs in their hollow shafts. This is accomplished by removing the Allen screws and shooting grease into the hollow shafts. The upper and lower pad rollers (Items 2, 6 and 7, Fig. 4) will also require semi-annual lubrication. This is accomplished by removing their knurled knobs, and shooting grease into their respective hollow shafts.

Under practically all operating conditions there is no necessity for any extra lubrication on the gear side of the projector. When delivered, the gear teeth will have been provided with a fine film of grease to aid in the running-in process. While it is not necessary to renew this film of grease, some projectionists will wish to renew it annually to assure continued quiet operation of the gears.

The only other lubrication task is to put some grease on the four points on the gear side of the inner shifting frame, as indicated on Figure 5, about once every six months.

The Intermittent Movement

Removal and subsequent replacement of

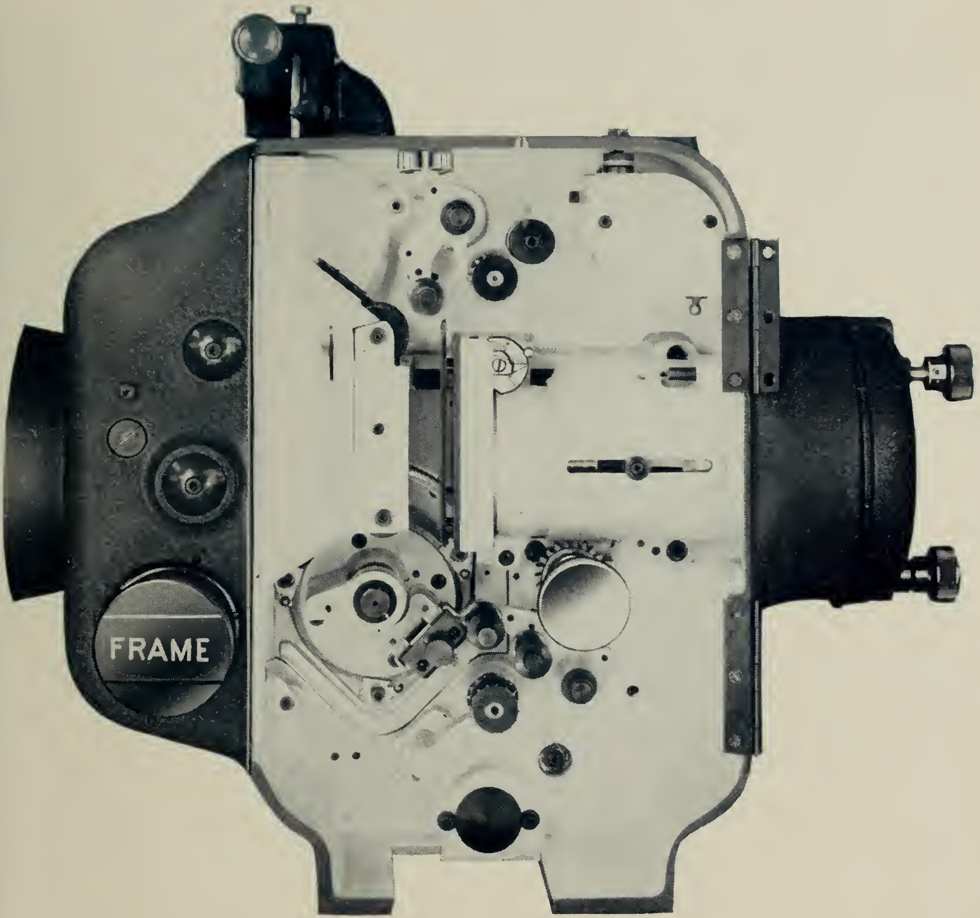


Fig. 4. Lubrication chart. Operating side of "AA" mechanism

Item 1. Upper guide roller
Item 2. Upper pad roller
Item 3. Upper film guide roller
Item 4. Lower film guide roller
Item 5. Intermittent movement grease plug
Items 6 and 7. Lower pad roller

the intermittent movement is a very simple process that can be accomplished in a few minutes' time, as reference to the following procedure will clearly indicate:

1. Remove the framing knob and covers on the gear side of mechanism.
2. Remove the fly-wheel on the intermittent movement by taking out the two Allen screws that lock the fly-wheel to the cam shaft.
3. Turn the framing knob to its "down" position.
4. Open the film gate and close the lower pad rollers.

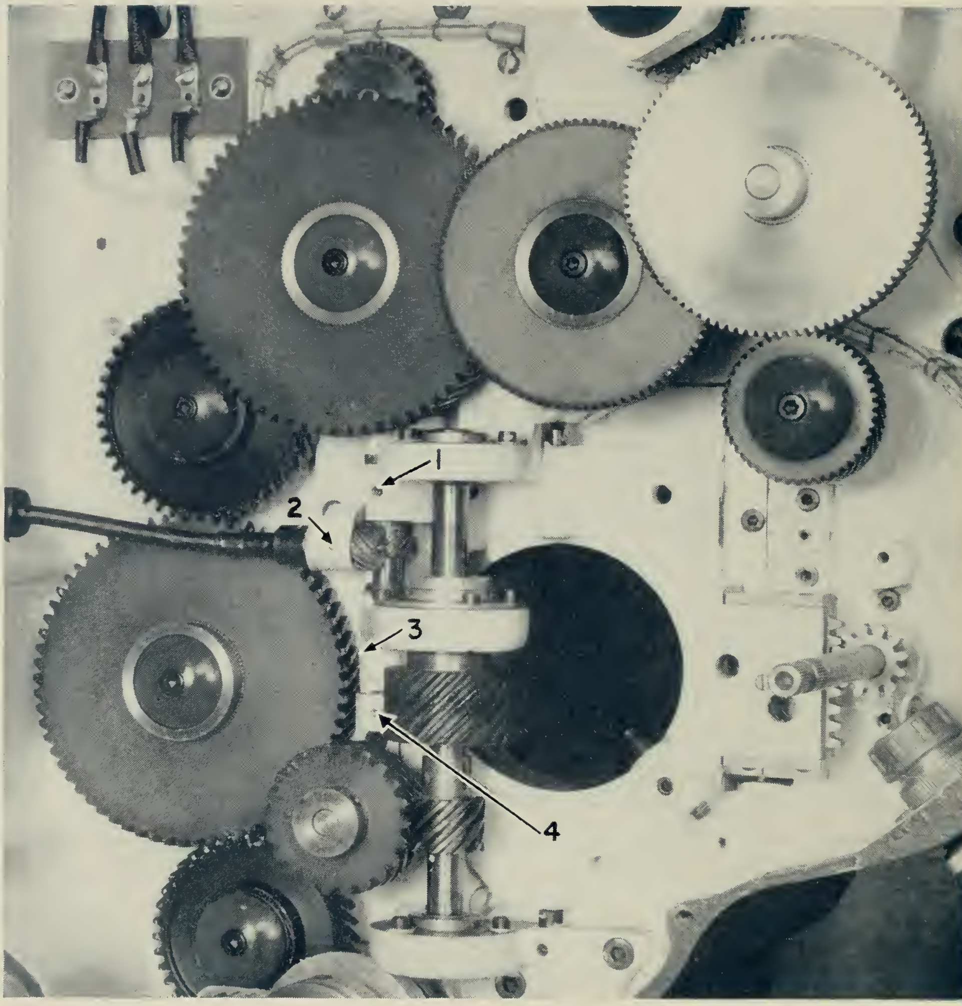


Fig. 5. Lubrication chart. Gear side of "AA" mechanism

Item 1. Hole to grease vertical shaft on timing adjustment
Item 2. Hole to grease gear on fine shutter-timing adjustment
Item 3. Hole to grease vertical shaft casting
Item 4. Hole to grease vertical shaft on timing adjustment

5. Release (do not remove) the Allen screws on the three clamps that hold the movement in proper position, and push the clamps away from the movement. (Clamps are located on operating side of the mechanism. See Fig. 6.)
6. Rotate the movement to the right about one-quarter turn, which will free the balance wheel pinion and permit the movement case to clear the

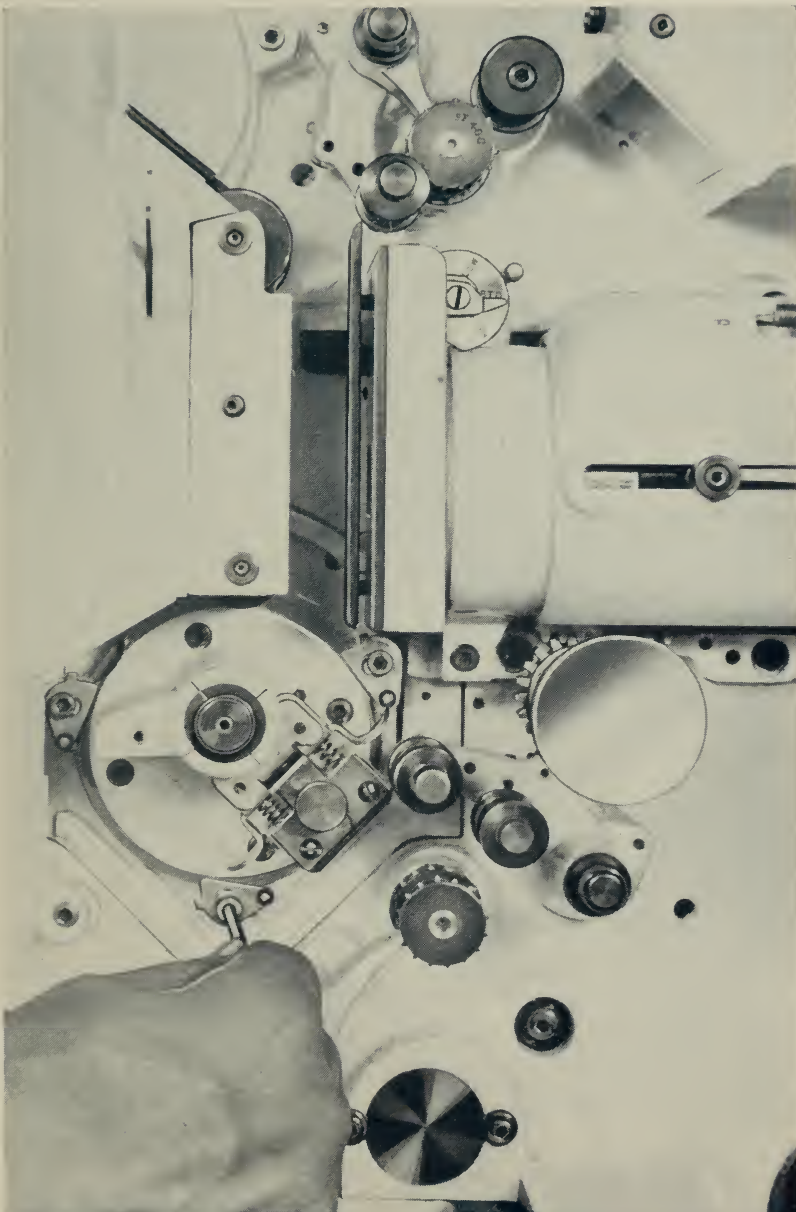


Fig. 6. Unlocking the intermittent movement

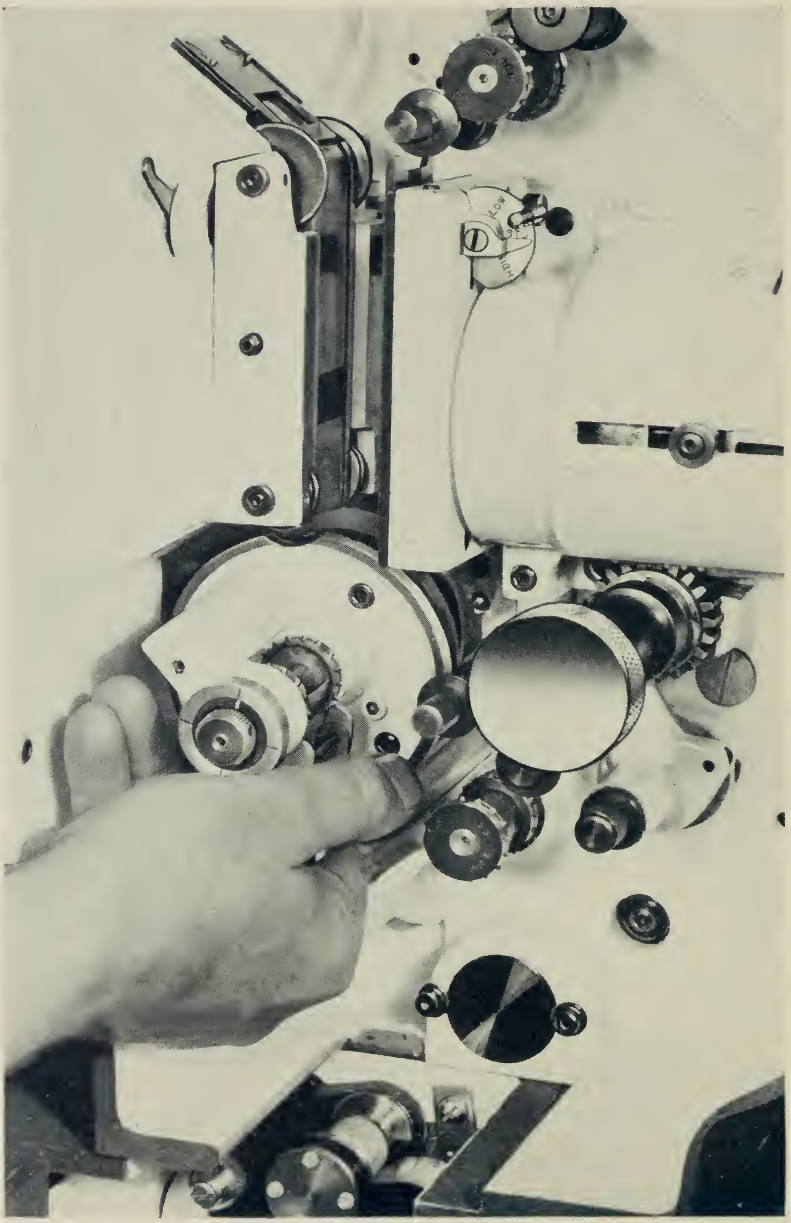


Fig. 7. Removing the intermittent movement

lower film guide roller. The movement can then be pulled out from the operating side. (See Fig. 7.)

The movement is replaced by reversing this procedure. When the intermittent movement is replaced, be sure that after insertion it is properly rotated so that the balance wheel pinion engages the movement drive gear and the movement case comes up tightly to the stop set in the inner shifting frame assembly.

Sprockets

The upper and lower feed sprockets are removed by taking out the Allen screws in the hubs of the sprockets. They can then be reversed or replaced quickly.

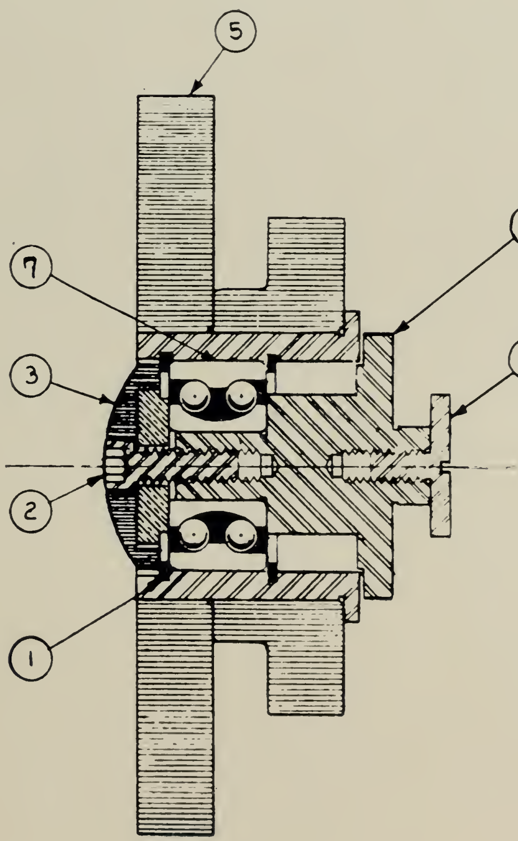
The intermittent sprocket can be reversed or replaced without the necessity of removing the intermittent movement from the mechanism. To remove the intermittent sprocket, back out the tapered screw in the hollow star shaft until it comes to a full stop, release the two screws in the locking collar and remove the collar, take off the outboard bearing by removing the single fastening screw which holds it on its locating dowels, release the stripper anchoring set screw at the bottom of the same hole, and slip out the stripper to release the sprocket.

Gears

Most gears in the gear train can be removed by simply loosening the Allen screw (Item 2, Fig. 8) in the face of the decora-

Fig. 8

Item 1. Ball bearing retaining ring
Item 2. Allen screw locking gear to stud
Item 3. Decorative dust cap
Item 4. Screw fastening stud to center frame
Item 5. Gear
Item 6. Stud
Item 7. Ball bearing



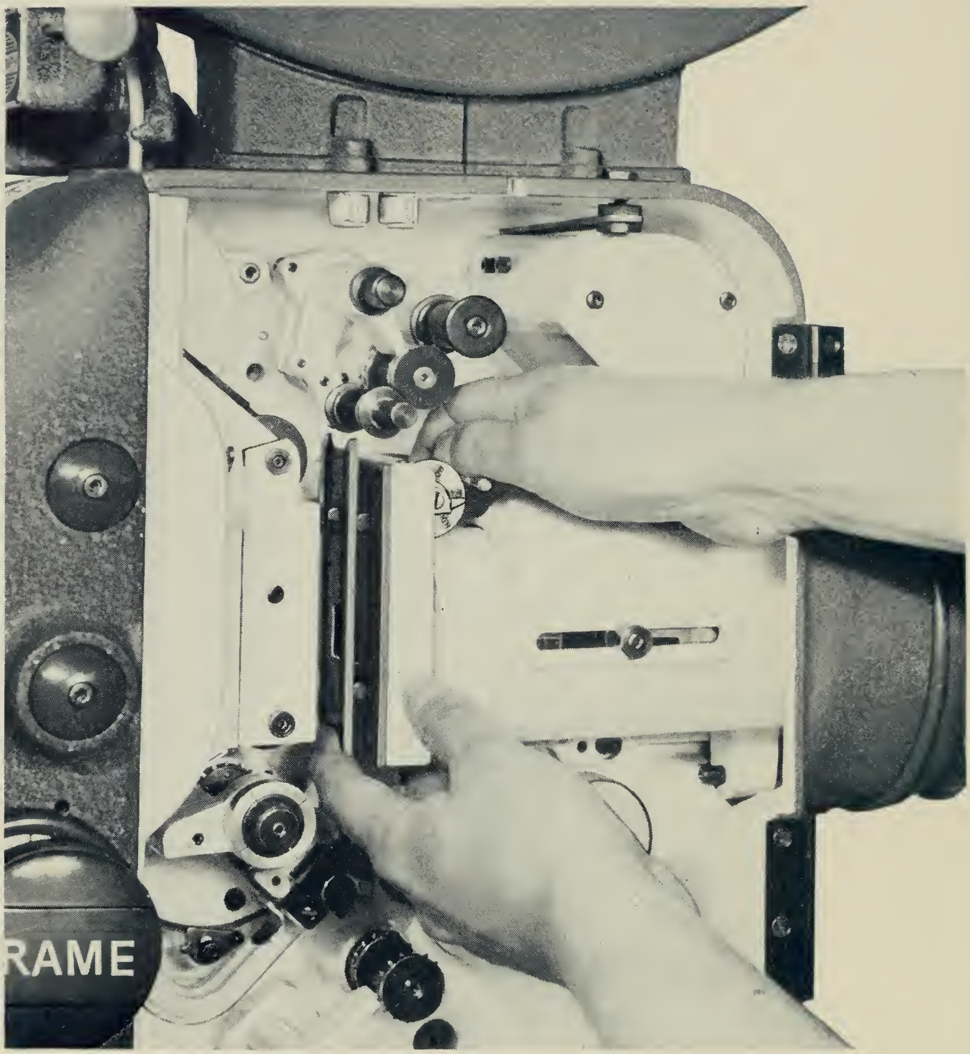


Fig. 9. Removing tension shoe

tive dust-cap (Item 3, Fig. 8) that fastens the gear to its attendant shaft or stud. (Item 6, Fig. 8.)

To remove the steel gear that meshes with the drive pinion of the projector drive assembly, it is necessary to remove the Allen screw (on the operating side of the projector mechanism) located below and to the right of the lower feed sprocket. The gear and its attendant stud can then be removed.

Bearings

All gears run on double-row grease packed ball bearings (Item 7, Fig. 8). The

outer races of the bearings are locked to the hub of the gear by a simple retaining ring. To remove the bearing, simply squeeze the protruding ends of the retaining ring together, and the bearing will come out of the gear hub. As the ball bearings used will outwear even the long wearing gears of the "AA," there should be no necessity for bearing replacement prior to the time when gear replacements are indicated.

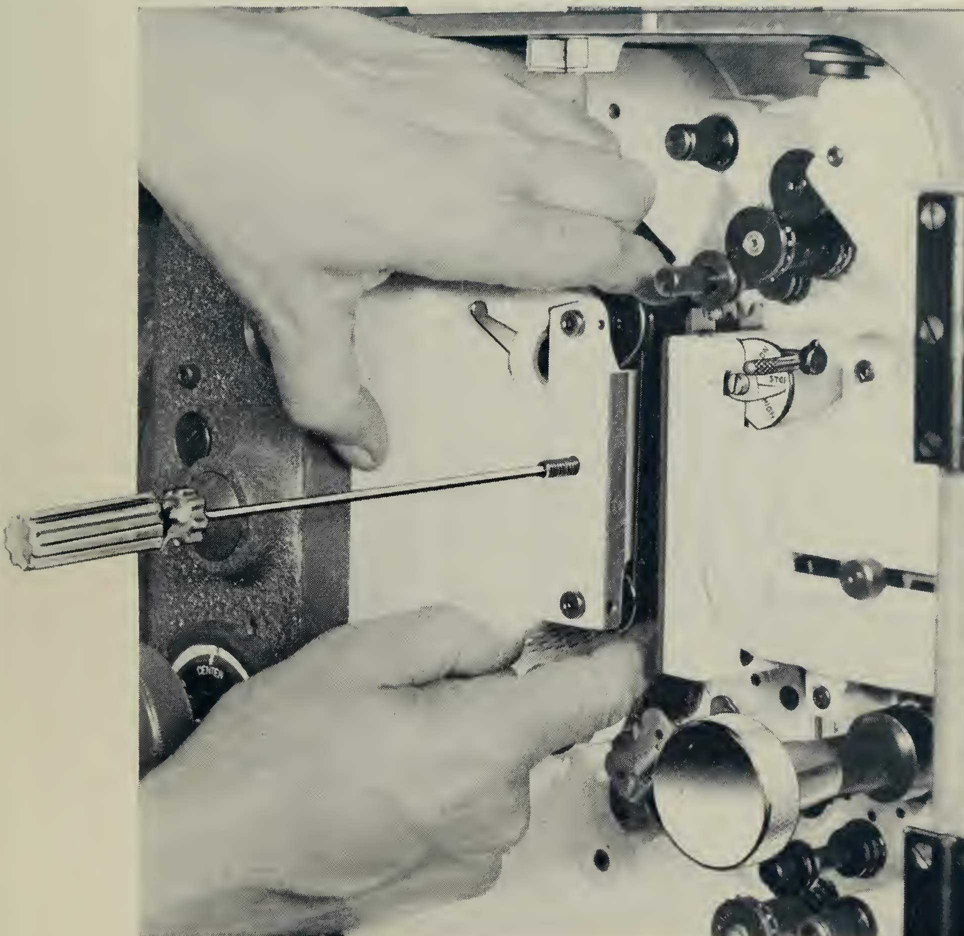


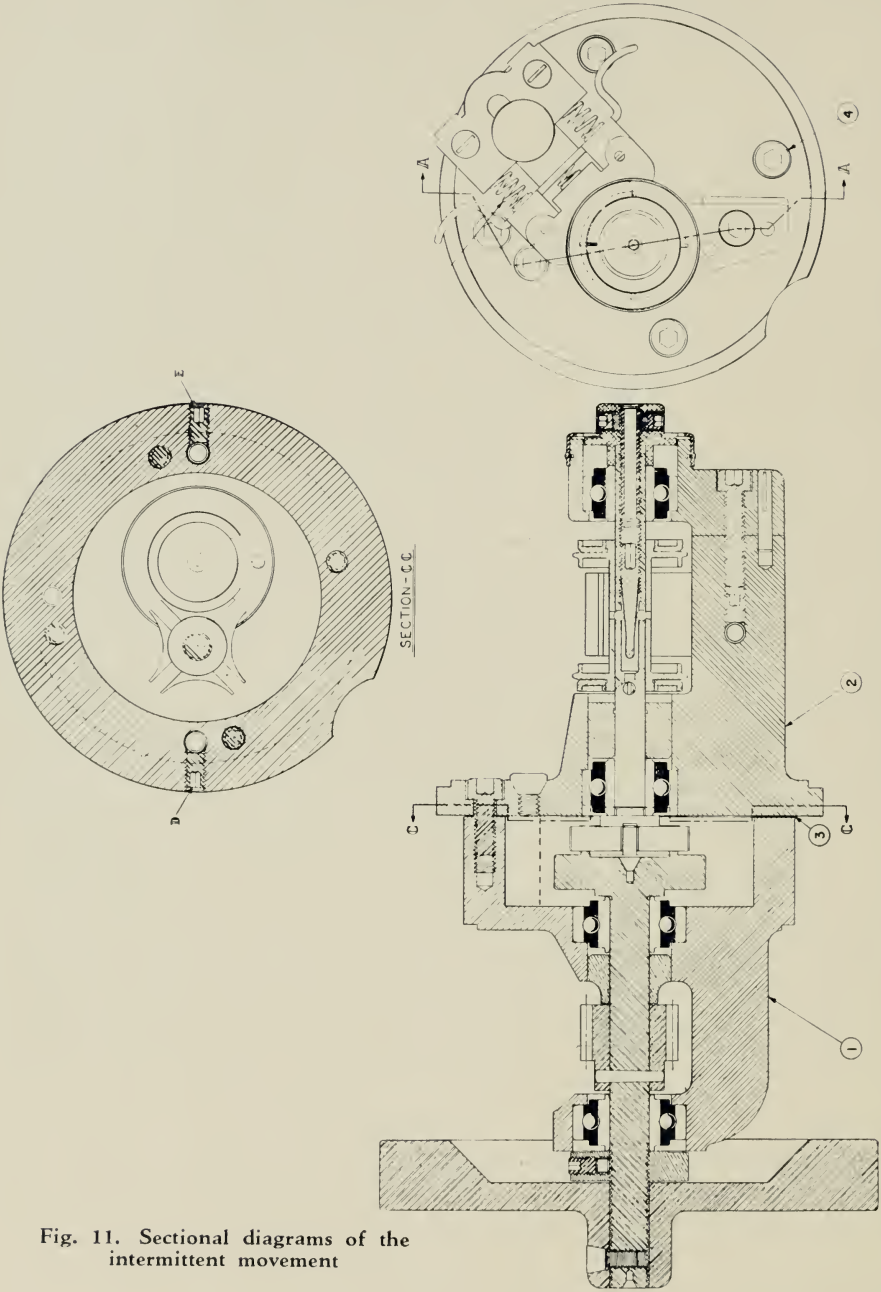
Fig. 10. Removing aperture and tracks

Shafts and Studs

Because the inner race of the ball bearing is securely locked to the gear, there is nothing turning on the shaft or stud, and consequently there is no wear on shafts and studs.

Lights

The framing light is replaced by removal of the cap on the top of the mechanism just



Item 1, Section AA. Movement housing casting
Item 2, Section AA. Movement housing casting
Item 3, Section AA. Gasket between housing castings
Item 4, Section A. Screws holding castings together
Items D and E, Section CC. Adjusting set screws

Fig. 11. Sectional diagrams of the intermittent movement

over the double shutter. The mechanism light is removed by taking out the two Allen screws that hold the cover of the light diffusing fixture. (See Fig. 9.) The mechanism lighting system is designed for 115 volt operation. Where local regulations prohibit standard lamps, low voltage lamps operating from a step-down transformer can be utilized.

Tension Shoe Removal

To remove the tension shoe unit for routine cleaning or replacement, pull back the plunger at the top of the gate body and then push up on the shoe unit and lift out. (See Fig. 9.) It is even more easily replaced by entering the studs on the tension shoe unit into the two gun locks on the face of the gate body and pushing the shoe downward until it locks shut.

Track and Aperture Removal

The tracks and aperture of the "AA" mechanism are one integral unit. This unit is removed by backing out the single, long, cone-point socket head screw which anchors the unit to the support casting. (See Fig. 10.)

Adjusting the Intermittent Movement

The two major movement housing castings (Items 1 and 2, Section AA, Fig. 11) are held firmly together with a gasket (Item 3) by four socket head cap screws (Item 4, Section A). Holes for these screws in the casting, (Item 2) are somewhat larger than the screw diameters, and this casting is movably pinned to the (Item 1) casting at a point just to the right of the upper screw hole (Section CC, Fig. 11). The two set screws (Items D and E of Section CC) set into the rim of the Item 2 casting, bear against pins fixed in the Item 1 casting, and extend into clearance holes in the Item 2 casting. It is thus possible to accurately adjust the clearance between the cam ring and the star radius surfaces by means of set screws D and E after slightly loosening the main fastening screws (Item 4).

Adjusting the Changeover

The electrical changeover device includes thermostatic protection for the operating coils. To speed the action of the changeover, turn the adjusting screw on the top of the changeover to the left. To slow the action, turn to the right.

Timing the Shutter

Timing of the shutter of the "AA" is a relatively simple matter and can be effected in a few minutes without the use of special tools and devices, using merely the Allen wrenches provided with the mechanism.

Following is the shutter timing procedure:

1. Turn the fine shutter timing control knob to a point where the two pinions are in the center of their travel.
2. Insert the hexagon wrench through the small reference hole located in the boss just below the gear, and revolve the movement balance wheel until the wrench enters the drilled reference hole in the end of the shutter blade.
3. Loosen the screw on the shutter drive gear to disengage the shutter blade from the gear train.
4. Leave the wrench inserted in the reference hole. Turn the mechanism over by hand to the point where the movement's cam pin is about to engage a star slot, as shown by alignment of the markings on the intermittent sprocket shaft's locking collar and on the position indicator cap surrounding it. (As a further check on the sprocket position, the projectionist may prefer to place his finger on the sprocket as it is turning, so that he can actually feel the cam pin engaging a star slot.)
5. Tighten the clutch screw, and remove the wrench. This timing arrangement is quite accurate, but any small errors in timing between shutter and movement can be compensated during operation by the variable fine shutter timing control located at the front of the mechanism.

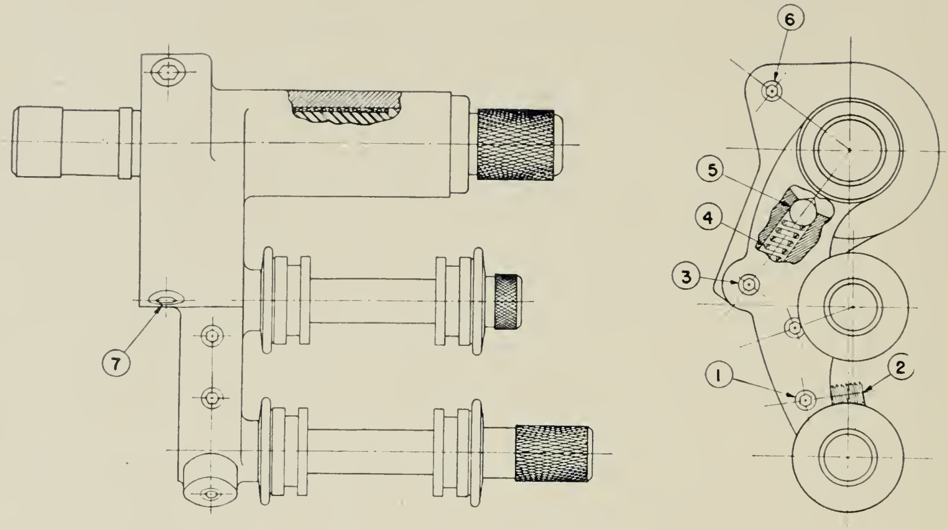


Fig. 12. Double pad roller

Item 1. Lock screw
Item 2. Adjustment set screw
Item 3. Lock screw
Item 4. Spring
Item 5. Ball bearing
Item 6. Lock screw
Item 7. Adjustment set screw

Pad Roller Adjustment

First loosen the lock screw (Item 1, Fig. 12). Then turn the screw (Item 2, Fig. 12) until the rollers are separated from the lower feed sprocket by an amount equal to two thicknesses of film. Be sure the rollers turn freely, and then lock them into position by tightening the screw (Item 1, Fig. 12). If greater or less tension in opening and closing of the entire pad roller assembly is desired, loosen the screw (Item 3, Fig. 12). To increase tension, turn the screw (Item 7, Fig. 12) to the right. To decrease tension, turn the screw to the left. The upper pad roller is similarly adjusted.

"AA" Magazines

Completely eliminated on the "AA" upper magazines is the familiar spring tension device of the old style upper magazine with its inefficient adjustment provisions. The reel shaft tension device on the "AA" magazine is fully enclosed, and its few working parts run in a bath of oil which should last for many months without change or addition.

The "AA" lower magazine is interchangeable with all other modern makes of magazines. It may be used with any projector mechanism or sound reproducer without changing its standard pulley or shaft, and it may be driven with modern V belts or round belts. The take-up is fully enclosed, and also operates in a bath of oil.

The adjustment of tension of both the upper magazine reel shaft and the friction take-up of the lower magazine is identical.

To adjust, remove the slotted screw and its attendant gasket on the rear of the magazine. Release the lock set screw, and turn the center screw in the desired direction. (Turning the center screw to the right increases tension—turning the screw to the left decreases tension.) After the desired tension has been obtained, the set-screw should be locked, and the gasket and slotted screw should be replaced.

• • •

A toothbrush is the best thing to clean shoes and tracks. If you are one of those fellows who insist on using a screw driver to do this cleaning operation, next time use a penny or a nickel, as the softer metal in these coins won't make a burr on tracks or shoes that will create some unlovely scratches on the next films you run.

• • •

If your aperture becomes smoky and dirty from a film fire, put a little peroxide on a rag and rub the aperture diligently. You will find it will look just like new.

• • •

If you have glass in your projection port holes, be sure that it is cleaned properly.

• • •

A projector mechanism that is cleaned properly will outlast a dirty one by many years, and the cost of upkeep will be materially less over its lifetime.

• • •

Keep the film gate, sprockets, guide and pad rollers free of emulsion if you are interested in saving film.

• • •

The proper clearance between pad rollers and sprockets is two thicknesses of film.

• • •

Keep the contacts on knife switches well burnished.

FILM

The Film Splice

Film exchanges have always endeavored to provide prints in first class condition, and thus do their part to bring about good picture presentation.

The principal cause of poor film conditions probably lies in the theatre booths themselves. Projectors, magazines, sound reproducers and film rewinders that should have been discarded are still in daily use in thousands of theatres throughout the United States and Canada.

We need do no more than mention the things that can cause film damage in the booth—rough handling, worn sprocket teeth, improperly adjusted film tension systems, improper tension of the take-up, badly adjusted idlers, and excessive speed in rewinding. Poor film splices are also the

Examples of good film splices

cause of much film damage, not to mention the difficulties they occasion in the proper presentation of pictures or in creating fire hazards.

Many Bad Splices

While undoubtedly every experienced projectionist can make a proper splice, many are sometimes careless and make poor splices. When you add these carelessly made splices to those made by green projectionists and film inspectors, you have generally poor film conditions that, of course, militate against good picture presentation.

There have come into the offices of THE SOUND TRACK a great many communications from projectionists remarking about the increasing number of poorly made film splices, so it must be that they are increasing.

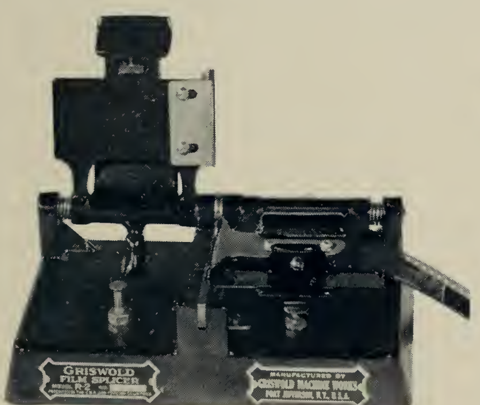
Some poor film splices

We urge first that each booth have a good, reliable film cement, and that the cement container be capped tightly when not in use.

A number of experienced projectionists

Steps in making a perfect film splice—first raise the left clamp and the upper jaw of the right clamp.

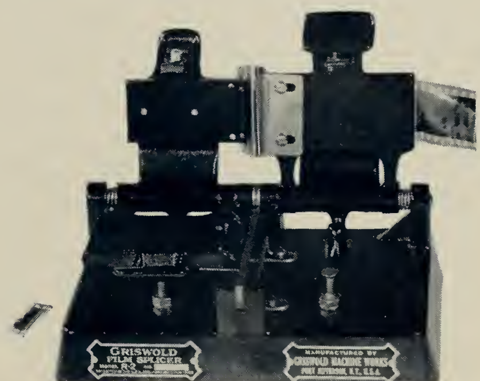
know how to make a good hand splice, but inasmuch as a mechanical film splicer can do the job so very much easier and better, we recommend the use of a good mechani-



Place the film emulsion side up on lower right jaw, and bring down upper right jaw.

Left film clamp has been brought down to cut film.

cal film splicer. One of the best, the Griswold, can be obtained in the U.S.A. for approximately $25.00—not a very large investment when one considers how many difficulties can be eliminated by its use.

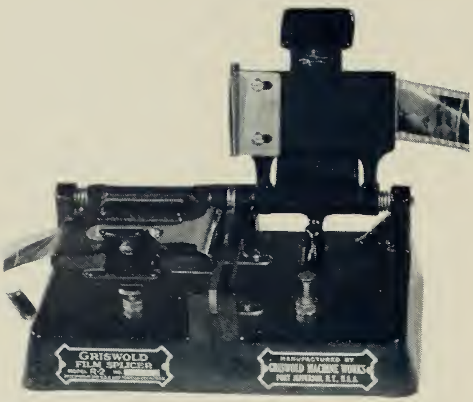


Right film clamp (with film) is raised.

How to Make Splices

A good splice requires that each end of the film be cut at exact right angles to the length of the film. A Griswold film splicer just can't cut the ragged ends of the film any other way.

Following is the proper procedure for film splicing, using Griswold film splicer Model R2 or Model T.



The other section of film, emulsion side up, is placed on lower left jaw, and upper left jaw brought down.

1. Swing up the upper jaw of the right film clamp against the stop, and swing both the upper and lower jaws of the left film clamp up against the stop.

2. Place the film, emulsion side up, on

Bring down right clamp to cut film and swing back again to stop.

the lower right jaw with a frame line on the left edge of the lower cutting blade, and bring the upper right jaw down on the film. (If you can't tell which is the emulsion side of the film, wet your lips and touch the film to them. The emulsion side will stick to your lips, while the celluloid will not.)

3. Bring down both the upper and lower jaws of the left film clamp which cuts the film.

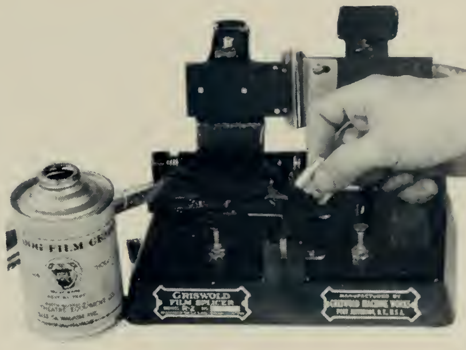
4. Raise both the upper and lower

With dampened felt disc, moisten emulsion of film on left jaw.

jaws of the right film clamp with film.

5. Swing the upper jaw of the left film clamp back against the stop. Place the other section of film, emulsion side up, with a frame line upon the left edge of

With brush end of scraper downward, insert lip between guide and lower shear blade, and scrape emulsion from film.



Apply cement to film.

the lower cutting blade, and bring the upper left jaw down on the film.

6. Bring down both the upper and lower jaws of the right film clamp which cuts film; then swing back both jaws of the right film clamp to the stop.

7. Moisten the emulsion on the film held by the left clamp overlapping the lower shear blade.

8. With the brush end of the film scraper, insert lip between guide and lower shear blade, incline scraper in the direction of travel, and scrape emulsion from center of film each way.

9. Brush off any particles of emulsion that remain on the film after scraping.

10. With the left hand, raise the left clamp with film so that the film is about ¼″ above the lower shear blade. While the film is being held in this position, apply cement with one stroke of the brush, then bring the left clamp down on stop and immediately bring right film clamp carrying the other section of film down on stop. After allowing a few seconds for the initial set of cement, raise the upper jaws of right and left film clamps and wipe off surplus cement with a dry cloth.

You now have a perfect film splice with the patch right upon a frame line, which will hold securely and eliminate the necessity for framing the projector during the showing of the film.

Bring down both clamps, and allow a few seconds for set of cement. You now have a perfect splice.

Film Splices and Film Care

From time to time THE SOUND TRACK has received and published letters from projectionists embodying some interesting and helpful ideas on film splicing, and film care in general. Pertinent extracts from these letters are reproduced herewith.

FILM SPLICES

I am enclosing a sample of a film splice I have been making for years and have found them supreme to any film patch ever made.

I was employed by the Canadian Universal Film Exchange in Toronto, Canada, as reviser of film, and made several hundred splices as per sample. After two years of use in theatres, I found several still in use, which only proves my statement that the sample enclosed is a supreme super dupe of a splice.

To make this splice, cut film in machine as usual and scrape off emulsion, then cut corners off as shown. This will prevent corners from

sticking up and pulling patches apart, as is often the case in the usual splice.

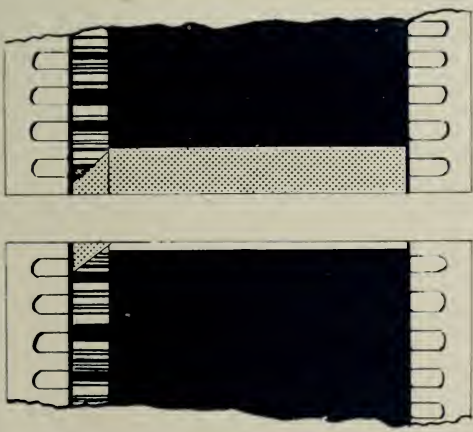
NORM. HILL.

Member Local 105, IATSE
London, Ont., Canada

An article interested me very much in regard to film patching. You published a picture of good patches and bad patches, and I agree with you wholly on your picture of bad patches. I have found many of these in prints which I have run. I also agree with you concerning your picture of good patches.

However, when I was learning to operate, my teacher taught me a trick which improves the sound track at the splice. Enclosed is a piece of film containing two kinds of splices. As you will notice, the upper one (both are made by hand without the aid of a splicer) is made exactly

the same as any film splice, the emulsion being scraped all the way across. Should the emulsion be scraped just a little too far, a resulting plop would be heard when the splice passes the sound gate. In the lower splice, you will note that the sound track contains a diagonal dark line, not put on with a pencil, but made in the splice. In this case the emulsion is scraped all the way across the picture up to the sound track. The sound track is then scraped diagonally up from left to right, and the sound track of the piece to be spliced on is scraped to correspond, leaving, when finished, the dark line you see in the splice.



I have tried both kinds of patches, and find that the latter gives much better results, besides cutting much unwanted noise from the sound. I have told several operators about this patch, but they claim "impossible." They say that by leaving any emulsion on the sound track the cement will not stick. I have always made my patches this way, and have never had a patch pull loose on me yet. I hope this suggestion may be tried by some of your readers.

GEORGE B. LORD.

244 Main Street
Bridgton, Maine

FILM REWINDING

Films can be damaged by unnecessary uneven rewinding. Many films come to my attention unevenly rewound. If the film inspector or projectionist takes his time and rewinds films even and smooth, there would be no damage on films. When a film is rewound unevenly, it will become tight by pressure when packed in the can, and the sides of the film will tend to bend, sometimes by their sprocket holes. The film inspector or projectionist must make a splice, thereby spoiling several good picture frames and making the scene uneven.

HOWARD SANORIA.

Kona Theatre
Capt. Cook, S. Kona,
Hawaii, T. H.

CUE MARKS

I have a suggestion and think it worthy of the projectionist's time to read. It is on THE *TREATMENT* OF *FILM*. I'm afraid there are a lot of projectionists who just don't care how the film looks after they are through with it. Maybe if they did, it would make a lot of operators, managers and patrons happier.

Here is what kills. You get in a print, and are checking it, and at the end of each reel where the Change-over cues should be, you find where some brilliant operator has used a punch, and there are four big holes in the film, or some deep scratches covering half the frame. There is no excuse for this. It ruins the show for the patron. If you splice out the holes, it takes time, damages the film, and in general just isn't the thing to do. Now if the cues aren't easy to see, and you think there might be a chance that you would miss them, use a little sharp instrument and make slight dots inside the original cue, or better still, slightly mark them with color pencil. The next man may not need them, and can erase them.

Another thing, there are plenty of prints ruined just because there are men that are too lazy to clean the fire pads and rollers. If you only do it every two weeks, it will help a lot. It only takes a little time, and the returns are terrific. Remember there are lots of theatres that will use the same print that you are showing, and they like to give their patrons a good show, too.

ROBERT M. SMITH.

Atlanta, Georgia.

I wish to offer a suggestion in regard to marking over films which has proven O.K. here over a period of years. At least, we usually find two or more reels in a show that aren't marked plain or else the marks have been taken out by some previous cutting, and so I have to put in my own marks. I do this with a china marking pencil which comes in either red or black and costs 15 cents, and which can be wiped off with no trouble at all. It will mark a thousand reels or more.

Suggestion 2. To clean dirt from the rollers at the top and bottom of the heads, I have a piece of film about one and one-half feet long with a dozen patches in it, which I put down

through the middle and both sides, top and bottom. The patches in the film do the removing of the dirt. Hope this does some one some good.

RAY KNIGHT.

State Theatre
Bridgton, Maine

Why not promote a campaign to equip every booth with a good splicer and a good marker, such as the Signo Marker made by Clint Phare Products. Some of the boys are butchering prints that are already properly cued.

SIDNEY R. PINGER.

Glen Theatre
Kansas City, Missouri

THE SOUND TRACK, in the interest of preserving prints and aiding projectionists, is also glad to recommend the purchase and the use of a Signo Marker, which your supply dealer sells for around $3.50.

We are publishing pictures of the Signo Marker and its scriber, as well as of film which has been cued with this device. Most projectionists will agree that the cue marks are a decided improvement over the many others one often sees.

The Signo Marker consists of a cast aluminum template and a hardened steel scriber. The template may be held in the hand or screwed to the re-wind table.

The standard position to make change over marks on film is twelve feet from the end for the motor start and one foot from the end for the changeover.

With the proper frame line even with the left hand edge of the Marker, drop the nearest sprocket hole over the steady pin.

Press down on the film so it will not move. Insert the scriber into the first hole. Press and turn the knurled knob one or two revolutions clock-wise. Repeat this procedure for the next three holes. The result will be four perfect circles of standard dot size in standard dot position. The center or fifth hole is merely a place to keep the scriber when not in use.

FILM CANS

Here is a little time saver you may wish to pass along to the boys. When you get one of those old I.C.C. cans that doesn't close right and you start to bang it with a hammer and stand on it, etc., try this: Take the film out of the can and put it on the cover of the can. Then pull the bottom of the can over the film the same as you would the cover. The results are surprising. The can closes as easily as a new one. Hope this helps someone who formerly cussed old cans.

LAWRENCE SCHEUERER.

7837 85th Street
Glendale 27, New York

ARC LAMPS

The Suprex Arc

Importance of the Arc Lamp in Projection

By C. S. ASHCRAFT

The best of the many thousands of top-flight projectionists of the country cannot achieve the acme of top-notch projection except with the right combination of quality projection room equipment—screen, lenses, projector, sound system, rectifier or generator, and last but not least, the projection arc lamp. The arc lamp, being the one really satisfactory light source for 35 mm. motion picture projection, therefore merits careful study by both the theatre owners who buy them and the projectionists who operate them.

A thorough explanation of all makes and types of arc lamps would take up fifty or more pages of closely printed matter, so I will not in the space allotted to me attempt to cover more than one type of lamp—the Simplified High Intensity Arc Lamp, all makes of which have become generally known by C. S. Ashcraft Manufacturing Co.'s trade name of "Suprex" lamps.

First let me digress to list the various types of arc lamp that are in use in the theatres of the country so that the reader may determine just where the Simplified High Intensity Arc Lamp fits in the entire arc lamp line-up. There are five types in use today:—

1. The straight high intensity
2. The simplified high intensity
3. The Cyclex
4. The "one kilowatt" high intensity
5. The low intensity

With the exception of the low intensity type, all of these types are modern, and each is suitable for the particular purpose for which it is intended.

Suprex, or Simplified High Intensity, Projection lamps have, within the past few years, become the standard means of motion picture projection in the great majority of large and medium sized theatres throughout the world. Their low cost of operation and dependability has caused them to become the ideal light source where economical, brilliant projection is required.

Maximum Light at Minimum Cost

Perhaps the most important factor in obtaining maximum light lies in the reflector employed by the manufacturer. The reflector must be designed to collect all of the light produced by the arc and concentrate it upon a very small spot (about 1¾" in diameter) at the aperture plate without spherical or chromatic aberration. If the reflector is of proper design, the aperture spot will be neither too small, which causes screen discoloration, nor too large, in which case there will be a distinct loss of light, but should produce a spot which is

exactly correct to project a brilliant and clear picture upon the screen.

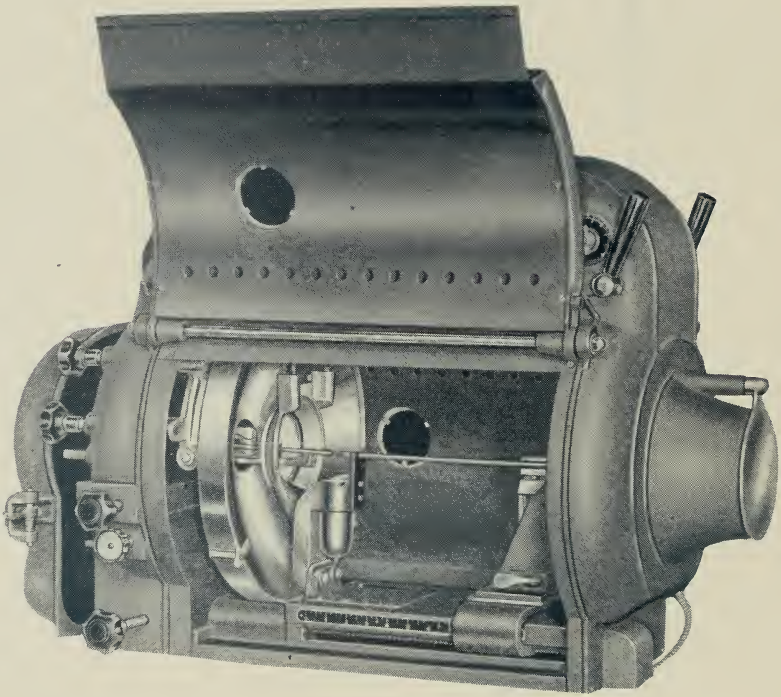
The reflector, however, has no part in maintaining a constant and uniform quantity of light on the screen. It is essential that the driving motor of the lamp be designed to feed the carbons at a predetermined rate which will always cause a uniform current to flow through the arc. Any motor will not do. It must be particularly designed to perform its very important function fourteen hours a day, if necessary.

Long life, which means minimum expense, is assured if the general design, gearing, carbon carriage drive, carbon holders and mirror protecting device are such that continuous operation over long periods of time will cause no wear on the component parts or burning out of parts due to heat.

Lamp Specifications

The lamphouse itself should be large and well constructed to provide the large interior needed to facilitate ventilation, to prevent overheating of the various parts and to keep the exterior cool. The lamphouse doors should be large, and when raised, expose the entire interior to the projectionist, making the cleaning and care of the lamp an easy task.

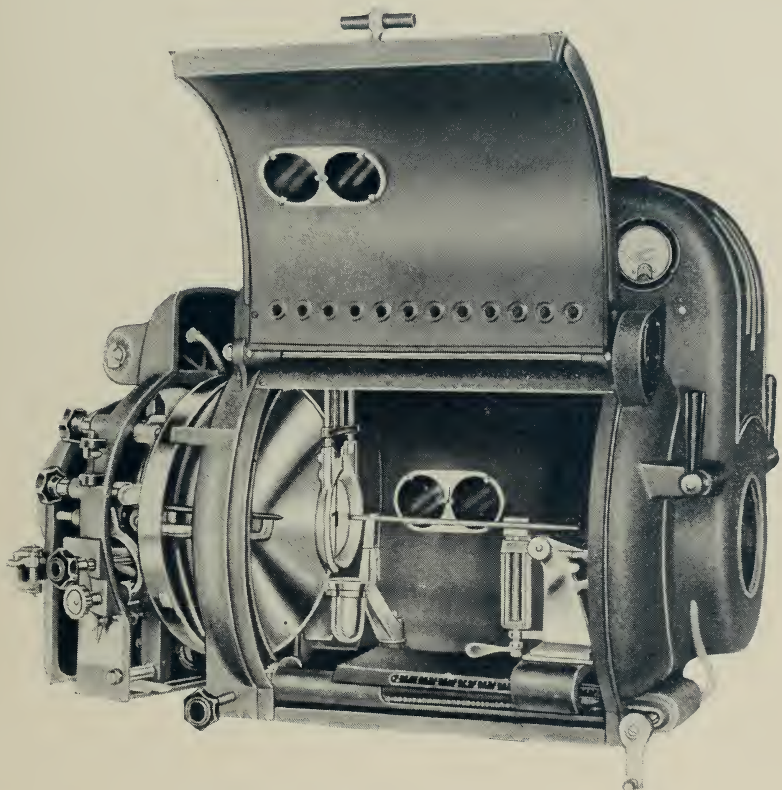
The reflector should be correctly and carefully designed to collect the maximum of light and project it upon the aperture with a minimum of loss. The magnifica-



The Suprex arc lamp, with reflector in position.

tion of the reflector should give both the correct aperture spot as well as one of great intensity. Due to the size of the spot, there should be no tendency for the projected light to have discolored sides or corners, the field being extremely flat under all operating conditions. The reflector should be placed a sufficient distance from the arc so as to minimize pitting, and to eliminate breakage from contact with the arc flame.

The positive carbon should be supported near its arcing end in a guide which is intended to hold the crater in the exact optical center of the reflector. The guide should be so positive as to eliminate any tendency of copper drippings collecting on the insulation and thus "shorting" it out. The guide should also be made of heat resisting metal and be non-magnetic in order that the arc will be unaffected by any magnetic influence caused by the passage of current through the carbon. The negative carbon must also be guided at its tip so as to be always directed in alignment with the positive carbon. This guide should be fixed in relation to the negative carriage, but the negative carriage should be so arranged as to be movable together with the guide vertically or laterally.



The Suprex arc lamp, with reflector moved back.

It is essential that convenient means be provided for moving the negative assembly in a parallel motion vertically and laterally relative to the positive carbon. Controls for this purpose are best located external to the lamphouse and convenient for the projectionist. In this manner only is it possible to maintain a perfect crater at all times.

Every lamp must have a shunt connected magnet coil. The purpose of this coil is twofold. It prevents the flame emitted by the negative carbon from spreading excessively over the outer edge of the positive crater, also to the rear of the crater face; in other words, it localizes the negative flame to the crater face. The second function is to bend the tail flame away from the mirror in order to eliminate undue heating of the mirror surface and smoke deposit.

An inherent characteristic of the Suprex Arc is the emission of flame and smoke upon striking the arc. There is also a tendency of liquid carbide, under certain conditions of operation, to be projected toward the mirror. In order fully to protect the reflector from these damaging agencies, a shield should be provided to fold around the arc when it is established, to preclude the possibility of damage to the reflector. When not in use, the shield should swing away out of the light beam. I do not recommend the use of glass shields over the mirror surface, as full protection of the mirror surface will have been provided by the dowser above recommended. The use of such shields may cause a light loss and light discoloration.

Carbon Holders For All Trims

It is impossible to anticipate the size of carbons most suitable in various theatres, as conditions of screen size, screen material and condition, and length of throw vary to a great extent. For this reason, the lamp must be designed with carbon holders which accommodate all sizes of carbons in the respective holders from 6 mm to 10mm, in the positive carbon holder, and 5 mm to 9mm in the negative, without the necessity of a change of parts for any of the various sizes. This is a very important feature, as it may be found necessary or advisable under certain conditions to make a change of carbon size, and the purchase of special carbon holders would prove expensive and their installation inconvenient.

Rapidity and ease of trimming is of great importance in the selection of a projection arc. There are times when the smooth presentation of the picture is jeopardized by the fact that the projectionist has unavoidably misjudged the amount of carbon to be used during the reel. A lamp in which this point has been overlooked may be the cause of a serious and long show interruption.

Relative Distances

The various lamp manufacturers provide diagrams which show the proper position of lamphouse to projector base. Usually all dimensions are marked from the unsilvered, or surface of the reflector nearest the arc. The distance from this surface to the aperture, which will also be the distance to the film, is 33½ inches, in case of the Ashcraft Suprex Type D. This distance will place the edge of the light opening in the front of the lamphouse 6¾ inches from the film. Other makes of lamps have different dimensions. If incorrect relation is established, the projected light will be poor and of a distinctly bluish cast. When projectors with rear shutters are used, the shutter shaft should not be allowed to strike against the lamphouse.

The distance of the front, or unsilvered, surface of the reflector to the edge of the crater in the positive carbon in all makes of simplified high intensity lamps is approximately five inches. This distance, in some cases, may vary slightly due to variation in reflectors, but for the purpose of preliminary alignment of the lamp, this distance may be taken to be correct.

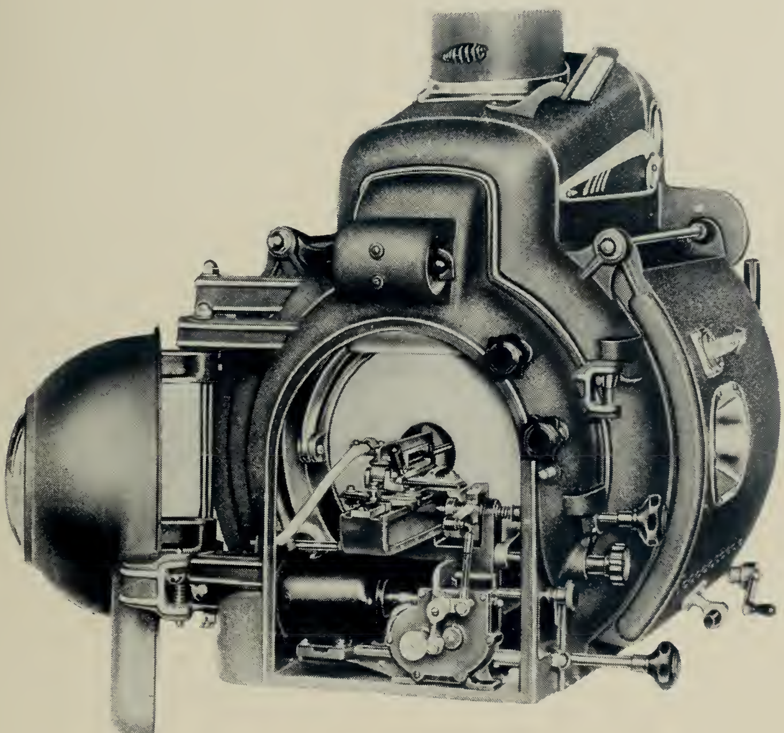
Carbon Holder Adjustments

It is not necessary to clamp the carbon excessively nor to such a degree that there is danger of crushing it. A moderate pressure

is sufficient. The forward end of the carbon should bear in the bottom of the guide groove. The positive carbon should not be too tight laterally in the guide groove, as there is a tendency of the carbon to swell when the arc is operating and binding of the carbon in the groove is apt to cause improper feeding.

where the positive crater is burned straight and at right angles to the axis of the positive carbon.

Always move the negative carbon into contact with the positive when striking the arc. This will always leave the crater of the positive carbon in its proper position relative to the reflector.



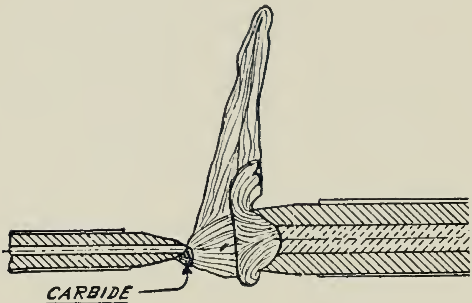
Rear view of the Suprex arc lamp.

The tip of the negative carbon should always center with the positive crater laterally. Vertically, the tip of the negative is usually positioned below the center of the positive. The distance below the center varies with the current used. An increase in current necessitates the lowering of the negative tip. The correct position will be

Selection of Proper Combinations

Current	*Neg.*	*Pos.*
30-40 Amperes	5mm	6mm
40-45 Amperes	5mm	7mm
45-50 Amperes	6mm	7mm
50-55 Amperes	6mm	8mm
55-65 Amperes	6.5mm	8mm
65-68 Amperes	7mm	8mm

It will be noted from the above that the comparative size of the negative carbon has been kept to a minimum. By so doing, a heavy deposit of carbide upon the tip of the negative carbon is prevented. At a given current, should the deposit be sufficient so as to form a definite bead or be in such quantities as to cause the arc to be unsteady as shown in the illustration, it may be decreased by using the next size smaller negative. The cause of this carbide deposit is the condensation of gaseous carbide, which is generated in the positive crater, on the tip of the comparatively cool negative carbon. By decreasing the size of the negative carbon, the temperature of the tip is increased to such a point that there will be little condensation. The gaseous carbide will flow past the tip without depositing.



EFFECT OF CARBIDE BEAD ON NEGATIVE TIP.

The selection of the proper size of the positive carbon, in many instances, must be left to the discretion of the projectionist. For instance, at a current of fifty amperes it is possible to use either the 6 and 7 mm combination or the 6 and 8 mm. The first will provide more illumination, but the burning rate of the positive carbon will be high. The latter combination will provide good illumination—not as brilliant as with the 7 mm—but the positive carbon consumption will be low.

Excessive economy, however, defeats the purpose of the lamp. An excessively low current on any given carbon will result in a yellow light which will vary, not only in intensity, but also in color. A medium must be determined whereby both reasonable economy and excellent illumination are obtained. At no time should a negative carbon be used which produces an excess of carbide on its tip. Not only does this seriously affect the light, but it is the cause of all mirror pitting. In no case should the arc be established without the inside dowser covering the reflector.

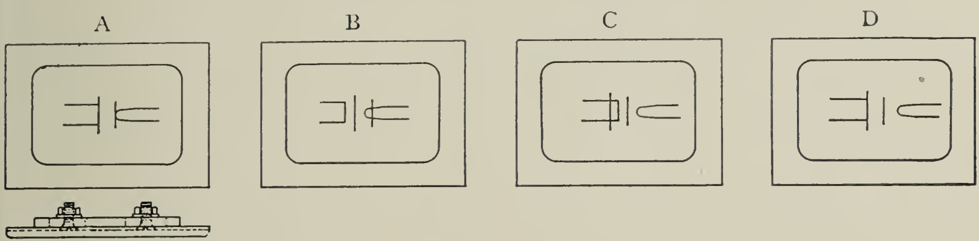
Adjusting the Negative Carbon Feed

The setting of the negative carbon adjustment is very important, and if improperly done will react on the feeding of the positive carbon; that is, if the negative feed is set too slow, the carbon will burn away and the positive will follow, feeding ahead of the line. Also, if the feed is too fast, there is a tendency for the positive to burn to the rear of the indicating line. To a certain extent, the regulation of the positive carbon is controlled by the proper regulation of the negative carbon.

Obtaining Maximum Illumination

After the correct distance between the reflector and the aperture has been set and the crater end of the positive carbon set at five inches from the reflector, the arc should be struck until the carbons are in contact and then the carbons separated and the spot centered upon the aperture. With the rear shutter operating, the light should be thrown upon the screen and the field cleared. Referring to illustration shown here, "A" shows how the arc should be set relative to the lines marked upon the gauge cord. By moving both carbons simultaneously to the position shown at "B," the light upon the screen will turn blue, and when in position "C," the light will be

yellow. At some point between these two extremes the light will be a brilliant white. The arc should be set very carefully, and if the image does not then coincide with the lines upon the gauge cord, the screws of the arc should be loosened and the mirror frame casting turned slightly until the image rests upon the gauge card lines. The setting of the crater relative to the reflector is of utmost importance, as all future results are entirely dependent upon this procedure. A light which is of too blue a cast indicates too small an aperture spot and should be avoided, as with this setting there is a tendency to obtain discolored corners and edges. Too large an aperture spot results in a projected light of a yellow color, which is not pleasing and also indicates a light of low reflective value.



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Arc control motor bearings should be oiled once a week with only a few drops of light oil, as over-oiling causes most failures.

Light From Suprex Carbons

By PERCY W. DECKER

It is probably true that Suprex Carbons are more generally used than any other type of carbon. They produce an intense bright, white light. They are consistent in their quality. Occasionally, however, the equipment needs to be checked in order to be sure that the best light possible is being projected on the screen. The purpose of this article is to provide a systematic check on the different factors which go to make up good light.

Let us start our check with the reflector and lenses. The reflector should present a clear shining, clean surface to reflect the best light. Bon Ami and a soft cloth are a good combination for cleaning the reflector. Should the reflector look cloudy and gray after polishing, it probably needs resilvering. The heat of the arc causes the backing to become loosened. A good job of cleaning can be done on the lenses with a piece of linen cloth and ordinary rubbing alcohol. The alcohol dissolves any oil, and the linen cloth leaves no lint.

Next check the alignment of the carbons with respect to the aperture. They should line up with the center of the aperture. This can be done with a straight metal rod of the same diameter as the positive carbon and long enough to extend from the posi-

tive carbon guide to the aperture. On some lamps it is possible to sight along the carbons from the rear of the lamp house. If you have such a lamp, you can easily check the alignment of the carbons with respect to each other. On the vertical plane the carbons should line up exactly. On the horizontal plane, the negative carbon should be enough below the center so that the crater of the positive carbon burns vertical at the edge. The reason for having a vertical crater is the fact that more light can be reflected than when the crater burns at an angle.

Now strike the arc and check the amount of voltage and current you use. All Suprex Carbons are marked with the maximum amperage which should be used. If you are drawing a higher amperage than is recommended, you are not getting the maximum use from the carbons. You will find that you burn more positive carbons than negative—that is, the ratio of positive carbon consumed to negative consumed is higher with the excessive current. The lowering of the current may be done by adjusting the ballast resistance if you have one, or by adjusting the voltage on the rectifier.

Checking With Light

Start the projector, without film, and project the light on the screen. Adjust the mirror until you have the brightest light in the center of the screen.

The color of the light is determined or affected by the distance of the reflector from the positive carbon crater. On lamps with an adjustable feed indicator, adjust the carbons by hand until you have the best colored light and then move the indicator cord to that position. Those lamps with the fixed indicator cord usually have adjustment with which the distance between the reflector and the positive carbon crater may either be shortened or lengthened. A yellow light shows that the distance is too short. A faint bluish light indicates that the distance is too long. For best light, a pure white is to be preferred. However, if there is just a trace of yellow, you will find when film is used this yellow is accentuated, so it is better to have a trace of blue rather than yellow.

After the color check, note the density of light on the screen. It should be of the same density over the entire surface. If there is a difference either at the center or the corners, it shows that the light is not focused at the aperture. To focus the light at the aperture, move the whole lamp backward or forward as the case indicates until you notice an even density of light at all points.

Compare Both Machines

This completes the check. Follow the same procedure on the other machine and then compare the two. This may be done by running both machines and using the changeover, or it may be done by raising both shutters and inserting a broken hacksaw blade at both apertures. The blade on one machine cuts off the upper portion of light while the lower portion is cut off on the other machine.

While comparing the light, check the positioning of each projector. Watch the lower edge of the screen to see whether the edge jumps up or down. If it does move, it shows that one machine needs tilting up or down. Also check for side jump, moving one or the other until this disappears.

Another factor which affects the light is the clamping of Suprex Carbons. These carbons are brittle and clamping them too tight causes minute fractures which cannot be seen or felt because of the copper covering. These fractures present a greater resistance to the current, with a consequent rise in current and the light becomes a blue shade.

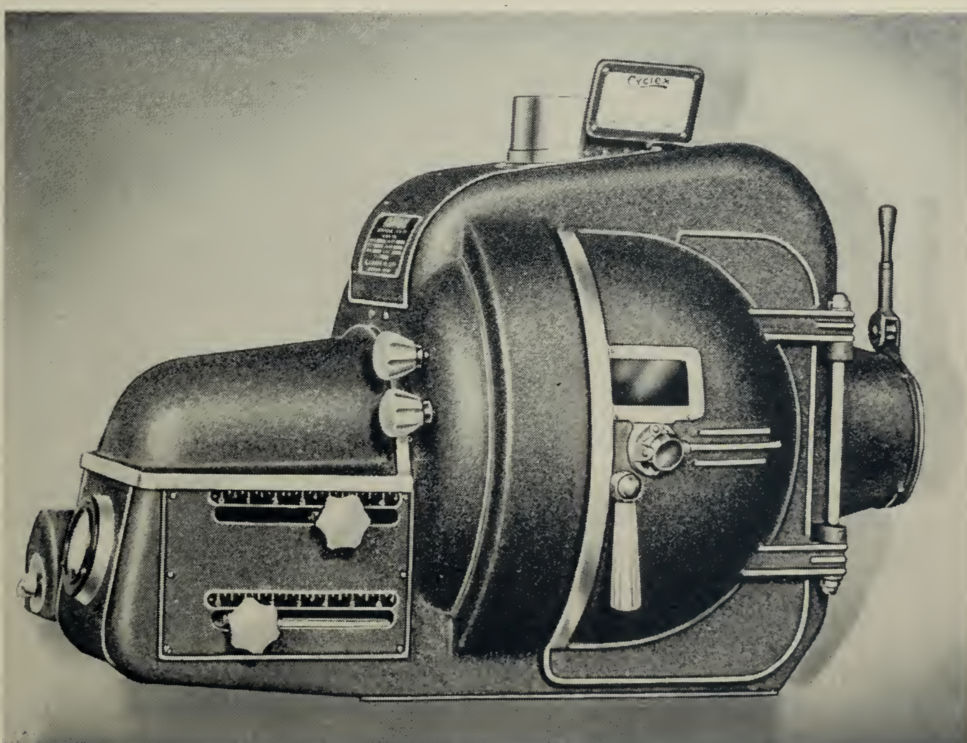
The lamphouse exhaust draft should be so regulated that the tail flame of the arc does not whip around, for this will show up on the screen in a flickering light. Enough draft should be had that the tail will move sluggishly only.

The Cyclex Arc

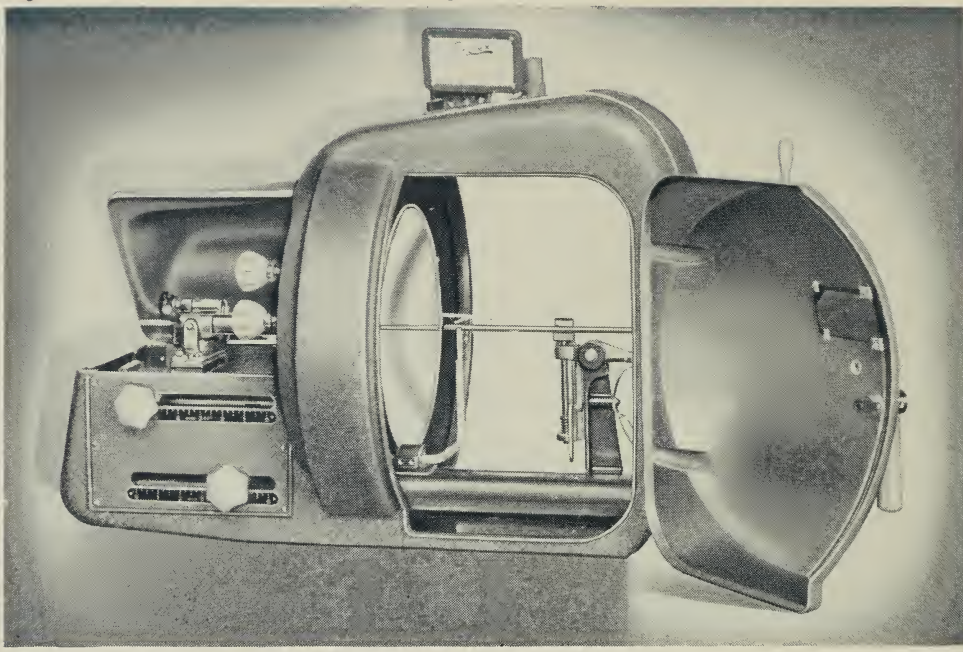
Outlining the Cyclex System of Projection

By C. S. ASHCRAFT

The purpose of this article is to provide a semi-technical explanation of the Cyclex method of light projection for motion pictures. The method of Cyclex projection consists of several separate and distinct developments, closely interrelated and coordinated in such manner that the result provides theatres of small and medium size with a power and light source which produces a brilliant, white and uniform light at a minimum of operating expense. Heretofore the great majority of



The Cyclex lamphouse, operating side.



Interior of the Cyclex lamphouse, showing burner mechanism

these theatres have necessarily had to rely upon the old intensity type of projection lamp, the light from which is yellow and low in value. Between the low intensity lamp and the type which would provide good screen illumination, according to modern standards, there is a wide difference in first and subsequent operating cost, so that the use of the Suprex type of lamp has been confined to the comparatively large theatre.

Cyclex is intended for those theatres which find low intensity totally inadequate, and Suprex unnecessary and the cost prohibitive. In other words, Cyclex provides the medium and small theatre with the same quality and quantity of light as has heretofore been enjoyed only by the larger theatres.

Outstanding Developments

Among the outstanding developments of Cyclex are:

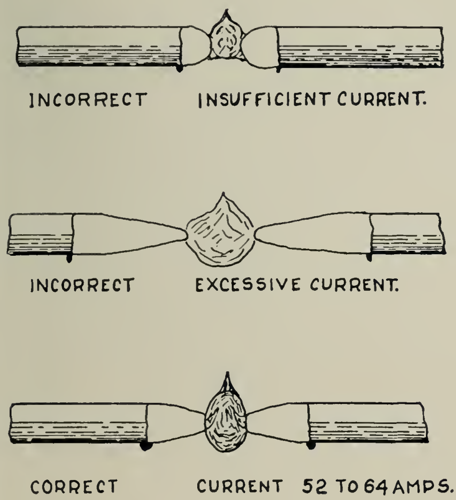
1. CYCLE-HARMONIC LIGHT PROJECTION

   A method of producing a light source for motion picture projection, employing alternating current and producing screen results heretofore obtainable only with direct current. Cyclex light is white, uniform and flawless.

2. CYCLEX POWER UNIT

   which produces a current of properly coordinated frequency for use in the Cyclex arc. The driving motor of this unit is less than one-sixth the size of those ordinarily used on motor generators for low intensity projection.

By a distinctly new method of current conversion it is possible to operate both arcs simultaneously from the Cyclex power unit without a change in screen illumination when the second arc is established, as is characteristic of many motor generators.



Proper arc gap for best results

3. THE CYCLEX ARC
which is quite different from all other arcs previously used for motion picture projection. The arc voltage is much lower than that ordinarily used, which fact results in an arc using less than one-half the power ordinarily consumed for much inferior projection. The low arc voltage results in an extremely low carbon consumption, but with an accompanying increase in light output.

Principles of Operation

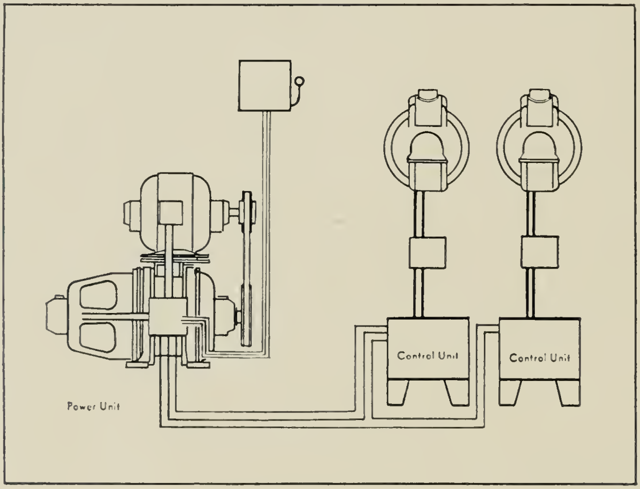
The Cyclex arc operates at a normal power consumption of approximately 1300 watts. While the power range is comparatively wide, excellent results will be obtained with this power input. The arc operates at an abnormally low voltage and comparative short arc gap, the latter being between 5/32″ and 3/16″, as shown in the illustration.

It has been found that by highly compressing the luminescent gas into such a short arc gap the intrinsic brilliancy of the arc is materially increased. In previous forms of the alternating current arc (using ordinary frequencies), the points of highest luminosity which were closely adjacent to the ends of the electrodes were not used to the best advantage. The presence of these points of high illuminosity was well known, but the fact that they were widely separated precluded the possibility of utilizing them to produce the greatest available light. By compressing these flames into a gap of approximately three-sixteenths of an inch, a dense flattened ball of flame is created having an exceptionally high intrinsic brilliancy. The Cyclex reflector is focused upon the densest portion of this compressed ball, resulting in an extremely high screen brilliancy for the power employed. Whereas the previous alternating current arcs have produced a light of bluish color, the Cyclex light embodies a full and well balanced spectrum in the range of 5700 kelvin, balancing all

The Cyclex power unit

colors into an ideal light source for both black and white and technicolor film.

In addition to the screen reduction in power consumption, the fact that is most outstanding is that the Cyclex arc normally consumes each carbon at the rate of from three to four inches per hour, which is less than one-half that of the ordinary direct current arc utilizing impregnated core carbons. Unlike Suprex or high intensity, the rate of carbon consumption is only in direct proportion to the power used, there being no point where the carbon consumption increases rapidly with a small increase in arc current. The above conditions result in an arc which is far more efficient and economical than any arc used heretofore for the projection of motion pictures.



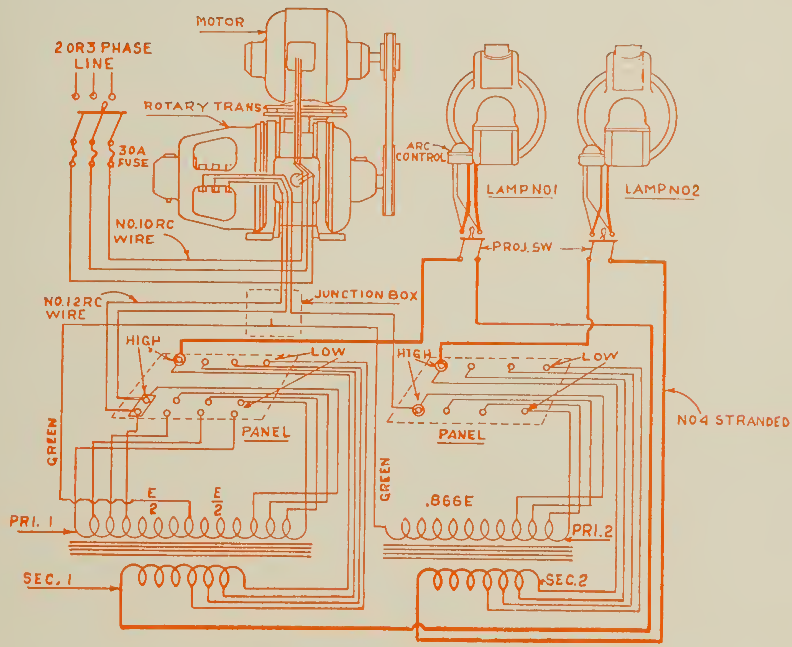
General wiring diagram

Co-ordinated Frequency Current

In order to produce the proper current for the operation of the Cyclex arc in the most practical manner and with the minimum of complication and resultant cost to the theatre, it was necessary to discard all previous methods of power conversion ordinarily used for motion picture projection and to develop and design an entirely new power unit, different both mechanically and electrically in principle and construction from anything used before.

While the most simple and inexpensive method of supplying alternating current to an arc is by means of an ordinary static transformer, operated on currents of commercial frequencies, unfortunately there is no commercial frequency which coordinates the frequency of the arm light pulsations with the shutter rotation and frequency. For producing a current of a frequency suitable for the projection of motion pictures it was necessary to develop a converter which was simple and efficient. This is accomplished by employing a rotary transformer driven by a comparatively small motor. Where operation of this rotary transformer or frequency converter polyphase current is essential, either two or three phase power may be used for operation of the unit, but in all cases the output of the unit is 3 phase 96 cycle current.

In order to utilize the 3 phase 96 cycle current to the best advantage in supplying power for two arcs singly or simultaneously, an ingenious system of interconnected transformers is used whereby three phase current is introduced into the transformers, but emerges as two phase. Thus one phase may be used in each of the projection arcs. So efficient and well balanced is the power supply that the lighting of the second arc has no visible effect upon the light being projected by the first. The general wiring diagram shows the general arrangements of the units.



Complete Cyclex wiring diagram

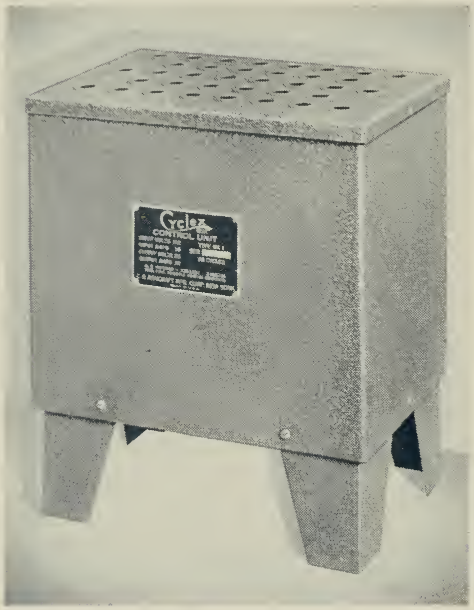
Components of Unit

The static transformers which receive the three phase current from the power unit and change it to two phase current are equipped with taps on both primary and secondary windings which allow for a comparatively wide range of currents for use in the arc.

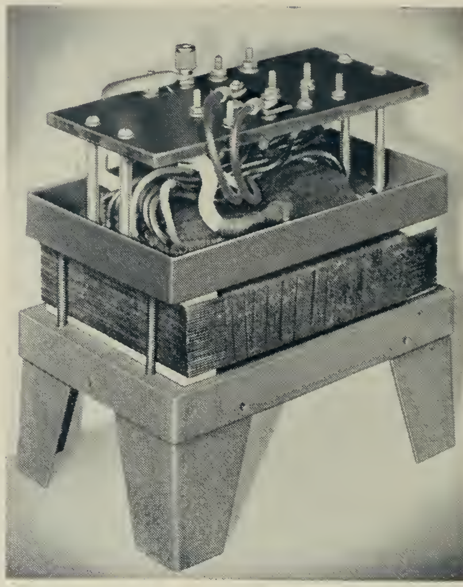
The frequency converters are made in various voltages, such as 220, 380, 440, 550, etc., and for operation on commercial frequencies of 25, 50 and 60 cycles. The photographs illustrate the appearance of the power unit proper. The lower section of the power unit contains the rotary transformer, an internal view of which is also shown. The unit is driven by a small motor mounted so as to form a compact unit with the lower section.

Power transmission is by a heavy Vee belt and adjustable pulleys, so that exact synchronization with the projector mechanism may be obtained. This latter is not essential, as a variation from synchronism

within a range of approximately ten percent does not visibly affect the results. From the rotating secondary of the converter the arc current is transmitted through collector rings and brushes and wired to the control units, where it is transformed to the proper voltage for direct use in the arc.



Cyclex control unit



Control unit with case removed

The converter is constructed of only such units as will have very long life. There are no commutators to wear, and the load on the bearings is so slight that possibility of a mechanical difficulty from this cause is negligible. Beyond a predetermined maximum output the current decreases through reactance in the control units, which prevents possible overloads on either the control units or power unit.

The Cyclex system of motion picture projection has proven itself through a number of years to be the most efficient and dependable means of current conversion for motion picture projection.

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Drafts through the lamp house may be strong enough to interfere seriously with stable operation of the arc. The installation of a damper in the lamp house stack may correct this condition.

• • •

Arc exhaust dampers and ducts from the lamphouses should be cleaned thoroughly of carbon ash and dust at least every three months. Failure to attend to this task may cause improper burning of carbons and pitted mirrors.

• • •

The light that strikes a pitted spot on the surface of an arc lamp reflector is diffused and largely wasted. A badly pitted reflector means a poorly lighted screen—and fewer patrons. A new pair of reflectors are not nearly as costly as one might expect. Better check yours today.

Arc Lamp for Drive-Ins

75/115 High Intensity Reflector-Type

The advent of the Drive-In theatre, with its tremendous 40 to 65 foot picture widths, and viewing distances running as great as 800 feet, has created a demand for high intensity arc lamps that will give greater light output and better light distribution than heretofore available high intensity lamps.

While reflector-type arc lamps operating in the 65-70 ampere range and condenser-type lamps operating in the 140-180 ampere range have given reasonably adequate screen results in Drive-In theatres with picture widths up to 40 feet and viewing distances up to 500 feet, they simply do not have the high light output to permit the patron to see a bright picture, particularly from viewing distances of 500 or more feet.

Motiograph is now offering new reflector-type high intensity arc lamps operating in the 75/115 ampere range. Field tests indicate that these lamps give more light when operating at 85 amperes than condenser-type high intensity arc lamps operating at more than twice this amperage. All other reflector-type arc lamps operate at a maximum of 70 amperes, so that the light offered by these lamps exceeds the light from other reflector-type arc lamps.

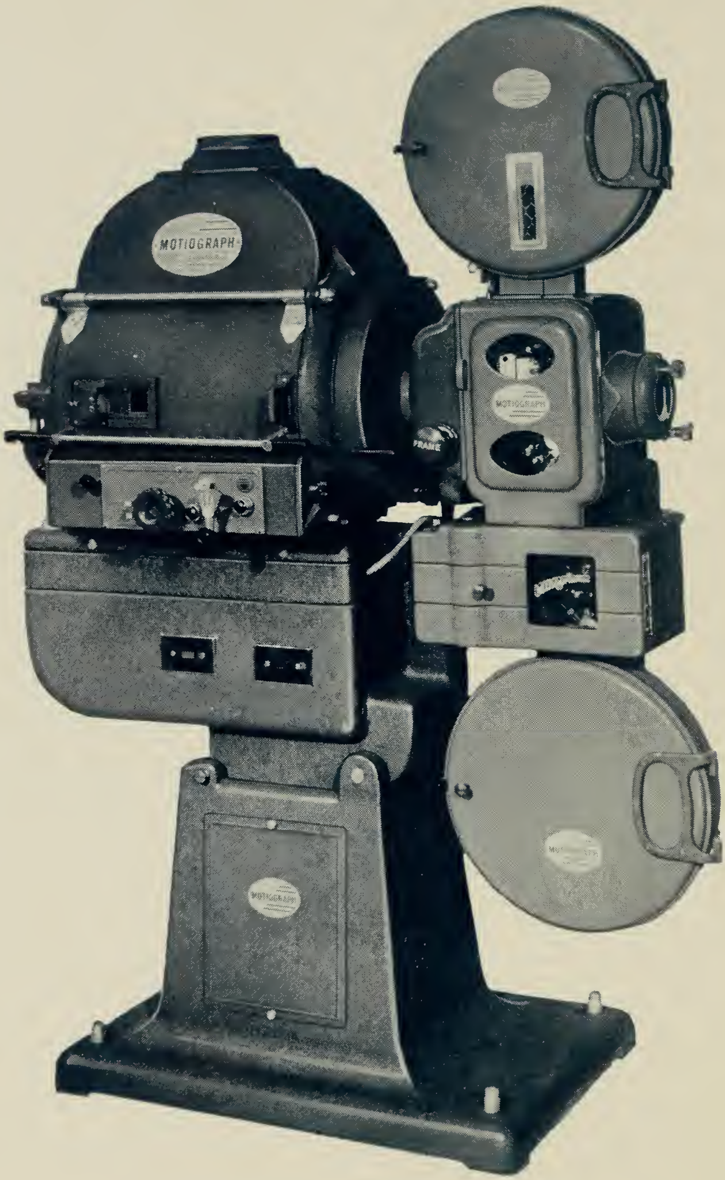
The reason that these lamps give more light is because of the employment of a rotating positive carbon which permits their operation at 75 to 115 amperes. Without a rotating positive carbon, even burning of the carbons and a proper crater form cannot be maintained.

The secret of the greater light output delivered by these lamps lies in the precise positioning of the carbons with respect to each other. The method of positioning employed permits the gases to be held back within the crater, where they become super-heated to extreme brilliancy. The ability of the large 16 inch mirror (largest employed in a reflector-type lamp) to collect maximum light also contributes to the greater light output. The device to maintain accurate focusing serves to produce maximum screen brilliance at all times.

Problems of Heat

High intensity condenser-type lamps burning larger carbons at higher amperages are capable of producing more light at the arc. Because of the acknowledged deficiencies of the condenser system in comparison to the reflector-system for collecting and focusing light on the picture aperture, such lamps cannot produce equal screen brilliancy, even though larger carbons and more current are employed.

It is to be noted that some manufacturers recommend the use of a glass filter between the arc lamp and projector to reduce the quantity of heat energy reaching the aperture. This is very desirable, as it prevents the film from reaching temperatures which cause buckling and consequently "in and out of focus" conditions. Unfortunately, all filters of this type reduce the visible light as well as the invisible heat energy. Consequently, even though



The Motiograph-Hall 75/115 High Intensity Arc Lamp, with the Motiograph "AA" Projector and the Motiograph-Mirrophonic Sound Reproducer

the source produces a large amount of light, the useful visible portion of it reaching the screen may be very little more than that which can be obtained from a lesser light source.

Due to the extremely high intrinsic brilliancy of the arc in the Motiograph lamp, the total light output contains a much larger percentage of visible light. It is thus unnecessary to use a filter.

The Motiograph lamps operating at 85 amperes have been installed with three different makes of projector mechanisms, and while some run cooler than others, in no case has there been any operational difficulty nor any report of film damage. It is, however, recommended that external blowers be used with the lamps to further reduce any possibility of film damage arising from heat.

The new lamps have been designed by Theodore O. Hall, whose lifetime of experience as a designer of high intensity arc lamps insures excellent screen results.

Improved Screen Brilliancy

Tests have indicated that these lamps produce 19,000 lumens of light operating at 85 amperes. This compares to 15,000 lumens offered by some high intensity arc lamps operating at 70 amperes. The lamp maintains constant screen brilliancy by a unique, yet simple, device that automatically holds the arc gap constant to compensate for variations in line voltage. The lamp's automatic focus control, a combination optical and electrical device, constantly holds the crater of the positive carbon at the exact focal point of the mirror within the exceptionally narrow limits of 7/1000ths of an inch. This feature prevents the usual variations in light intensity that often prevail when using lamps with less precise focus control.

Low Operating Cost

The lamps are designed to use either currently available 9 mm or 11 mm high intensity positive carbons. When completely developed 10 mm carbons become available, they, too, may be used. The cost of 9 mm positive and 5/16 inch negative carbons is very little more than the cost of the 8 mm positive and 7 mm negative carbons used in reflector-type arc lamps in the 65-70 ampere range. The cost of carbons is about one-third of the cost of the Super H. I. 13.6 positive and 7/16 inch negative carbons used in condenser-type lamps operating in the 140-180 ampere range.

The 16 inch diameter reflectors are only slightly higher in replacement cost than the smaller sized reflectors used in reflector-type high intensity lamps in the 65-70 ampere range, and very much less costly than either the glass or quartz condensers used in condenser-type lamps operating in the 140-180 ampere range.

Simplicity of Operation

Once the arc is struck, the projectionist need only watch the pilot light on the lamphouse, which indicates how the lamp is performing. This light flashes when the current varies above or below normal, and indicates that the automatic focus control is functioning. Constant adjustment of the manual controls by the projectionist is therefore unnecessary.

There is no need for the projectionist to periodically adjust the reflector. The reflector in its holder is permanently mounted and forms the rear door of the lamphouse. This method of mounting the mirror and securing it so that it cannot be moved renders it certain that the reflector, the aperture and the lens will always be in perfect optical alignment.

Should, by remote chance, the automatic focusing device fail to operate, the projectionist can operate the burner mechanism by means of a conveniently located knob in the operating side of the machine. At initial installation time the entire car-

riage is positioned so that the light spot will be of the correct dimension and centered on the aperture. In the event the burner mechanism should be removed and subsequently replaced, so that the relation of the spot to the aperture is disturbed, manual adjustment to raise or lower the carriage or to move it from side to side may be made by two additional knobs located on the operating side of the lamp.

The Motiograph-Hall 75/115 High Intensity Arc Lamp, a reflector-type arc lamp with light output needed for Drive-In theatres

Construction of Lamp

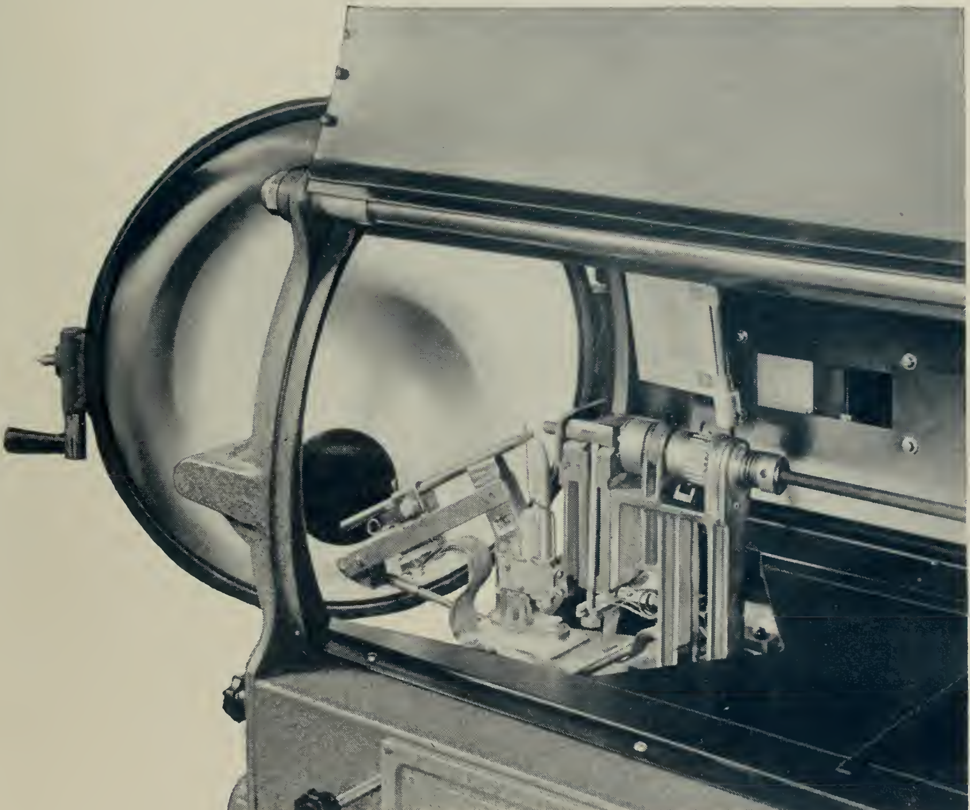
The moving portions of the lamp consist of comparatively few machined parts. The arc burner mechanism is built as a complete unit which can be readily removed if servicing is required.

The large roomy housing is constructed so that the inside surfaces are smooth to facilitate cleaning. As a further aid in

cleaning, a false bottom is provided which extends under the entire burner mechanism and which can be readily removed.

The positive carbon contacts are made of bronze having the best heat conductivity consistent with resistance to oxidation and scaling. The contact surfaces are lined with pure silver 1/16th of an inch thick. These materials readily conduct current and carry away the heat rapidly, yet will not scale.

The lamphouse consists of a formed heavy gauge sheet-steel base, to which are attached, by means of polished steel rods, two sturdy aluminum castings which form the front and back of the housing. Both doors are double-walled to effectively insulate the outside surfaces from the high arc temperature. The usual ruby glass observation ports and arc image projector are provided.



Detailed view of the Motiograph-Hall 75/115 High Intensity Arc Lamp, showing the positioning of the carbons, the rotating positive carbon, and the large 16 inch mirror

• • •

The hard scum that forms on the arc lamp reflector will, if allowed to remain on the surface of the reflector, burn itself into the surface of the glass. Then it can only be

scoured off by considerable polishing with Bon Ami used on a slightly moistened cloth.

• • •

Carbon particles which may adhere to the surface of an old reflector may be scraped off with a flexible razor blade and then subsequently polished with Bon Ami used on a slightly moistened cloth.

• • •

Fine though carbon dust may be, it still can act as an abrasive—and gears and shafts just don't get along well with abrasives. Moral: keep your lamphouse free from carbon dust.

• • •

Speaking of carbon dust, the worst enemy of proper amplifier performance is that same carbon dust. Carbon dust seeping into a switch, volume control or filament rheostat will create variable resistance at those points, causing noisy sound. Properly cleaned booth equipment means a better picture and high quality sound, plus longer equipment life.

"You state that you are the greatest motion picture actress in the world. Don't you think that sounds a little egotistical?"
"Perhaps it does, but you must remember, your honor, that I'm under oath."

GENERATORS

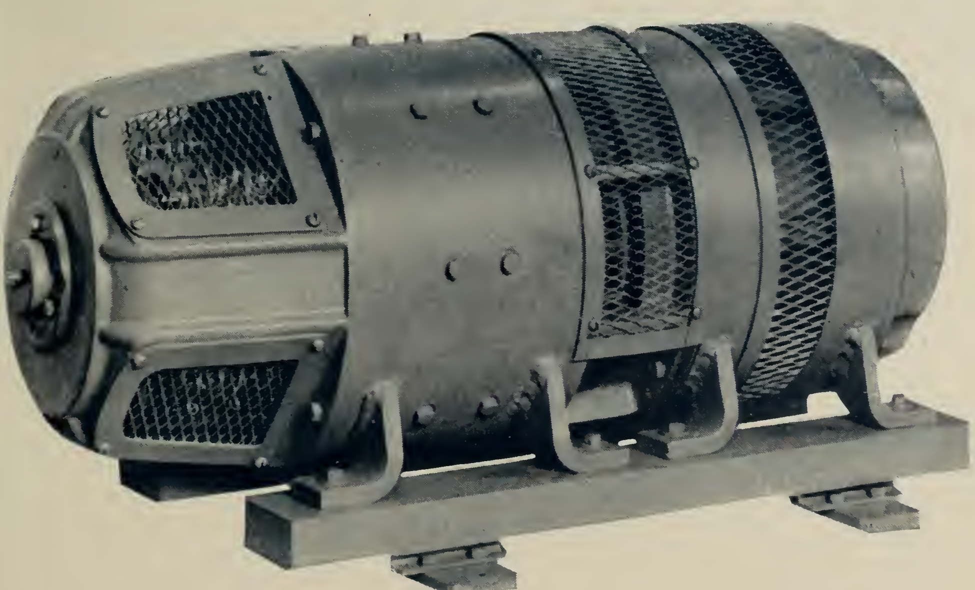
The Motor-Generator

Projection Lamp Power Supplies

By J. E. ROBIN

(The late Mr. Robin, with a background of nearly thirty-five years in the motion picture field, was recognized as one of the outstanding authorities on projection engineering. Among the many companies with whom he has been associated in an executive and consultant capacity are included the Precision Machine Co., International Projector Co., Nicholas Power Co., Strong Electric Co., Brenkert Light Projection Co., Kollmorgen Optical Corp., Century Electric Co., and the Imperial Electric Co.)

The economic advantages obtained in transmission and distribution derived from the use of alternating current is the princi-



Standard single unit two-bearing multiple type arc motor-generator

pal reason why it has become the universal power supply.

With few exceptions theatres everywhere are served with alternating current at a prevailing frequency of 60 cycles in the United States and at 50 cycles in other countries. This form of electrical energy reverses its direction of flow in a periodic manner rising from zero to maximum strength, then going through similar variations in the opposite direction many times per second, with each change comprising a cycle, as contrasted with direct current (D.C.) which flows continuously in the one direction.

A.C. Operation

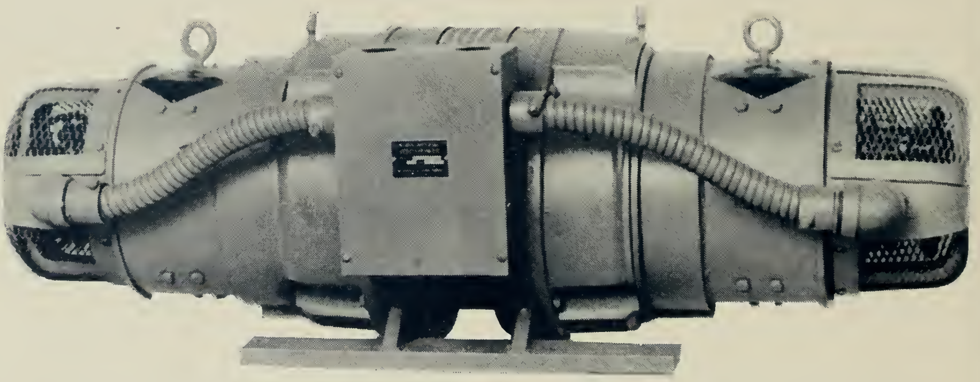
When the carbon arc first came into use as a projection light source it was customary to use whatever power was found available. The difficulty from A.C. operation of such arcs lies in the fact that the alternating current flows freely in one direction for an instant and then in the opposite direction. This reversal causes each carbon to be positive half the time and negative the other half. Therefore, the energy is divided between the carbon tips, forming two craters of fluctuating temperatures and light radiation.

In the early days illumination requirements were low. The old style inclined arcs of low voltage and heavy current used in conjunction with a condenser system sufficed.

With progressive changes in arc lamp design the direct use of alternating current as an arc power supply has, with one exception, ceased. This being the high frequency alternating current arc using copper coated carbons, originally pioneered by the writer. It is suitable for installations which require only moderate screen illumination.

The Use of D.C.

The superiority of direct current as an arc power supply was soon established and it became and still is a general practice to first convert any form of alternating current to D.C. before using it for arc lamp operation.



Duplex single-unit multiple type arc motor-generator for Superex arcs and standard spotlight and effect machines

By doing so, one carbon is always maintained positive, resulting in a stabilized quiet arc of increased efficiency. The great majority of light is radiated from the crater of the positive carbon, providing almost a point source. This makes possible the use of simple yet highly efficient optical systems as a means of utilization to pick up the maximum available light and focus it uniformly at the projector mechanism aperture.

These optical systems are an elliptical type reflector, a parabolic reflector used

with a condenser lens or a doublet condenser system as used in the high current high intensity arcs. Such arcs give very uniform and extremely brilliant screen illumination not equalled by any other known light source.

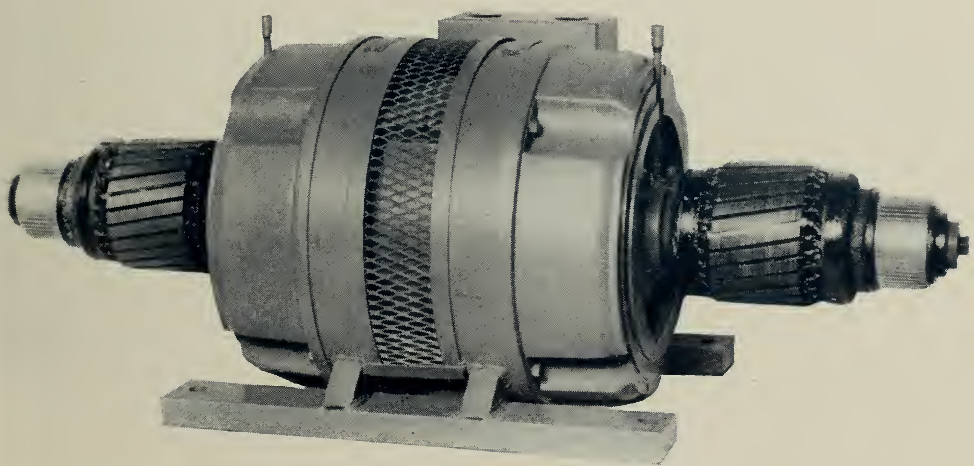
Equipment for Conversion

There are two classes of equipment commonly used in motion picture theatres for the conversion of the A.C. power supply to direct current suitable for arc lamp operation—rectifiers and motor-generators, with the exception of high intensity 110-160 ampere lamps, which are powered exclusively by generators.

Direct current is a uni-directional current; however, it may be constant or periodically fluctuating as rectified A.C.

A rectifier is usually of a single arc type and converts A.C. into a pulsating current. The types available for projection service may be classified in two groups, i.e., the dry junction type using stacks of either Copper-oxide, Magnesium-copper, Sulphide or Selenium units or the gas bulb type utilizing two or more Tungar, Rectigon type bulbs. The remaining equipment is comprised of transformers, choke coils and ventilating fan and terminal board. These rectifiers function as an electronic valve, which permits the current to flow substantially in only one direction. By suitable circuit design, this pulsating uni-directional supply can be filtered for arc lamp operation.

Motor-generators are rotating electrical machines consisting of a combination of a motor and generator(s), which function to convert the mechanical energy developed by the motor into generated direct current independent of the A.C. line voltage and as a separate unit permits a fine degree of voltage regulation.

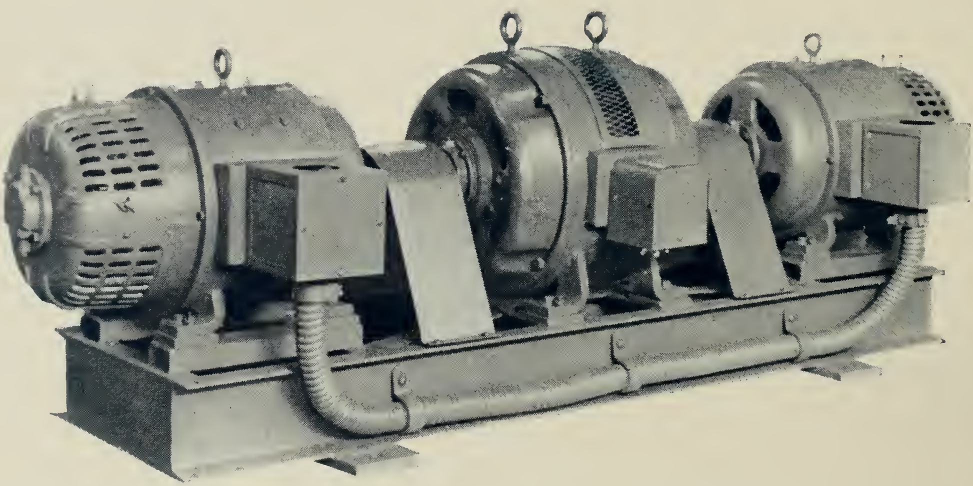


Duplex single-unit multiple type arc motor-generator, with generator field housings and end bells removed to show armature and commutator construction

In most two bearing motor-generator sets the A.C. motor rotor and the D.C. generator armature are mounted on a common shaft. In others, particularly the larger rated four bearing types, the motor and generator(s) are individual units mounted on a common bed plate and coupled by means of a semi-flexible coupling unit. It is standard practice to furnish some units with vibration Floating Power type base mountings.

Rectifiers or Motor-Generators?

The various types of rectifiers and the different styles of motor-generators all have their champions. The choice depends upon the application and other factors, but the writer is of the opinion that motor-generators are presently the best source of a steady direct current supply for arc lamps for the following reasons:



Duplex three-unit multiple type arc motor-generator for Suprex arcs and standard spotlight and effect machines

1. **Great dependability and ruggedness.** For theatre use this is important: it is the Boxoffice life line and the means that all of us in show business live by. The old adage, "The Show Must Go On" is not subject to compromise, therefore, the generator set is well constructed mechanically, of dependable electrical design for the service and having few components it is not likely to suddenly quit functioning or get out of order.

2. **Excellent operating characteristics.** Motor-generators are less affected by power line voltage variations than other types of power conversion equipment because of the inherent performance stability of the AC driving motor and independence of the generating unit. By careful design of the DC generators the characteristics can be exactly suited to the projection arc service requirements.

A low commutator ripple frequency and stability of the output voltage when operating under a mixed load with arcs of different voltages are features that are exclusively limited to generators. Duplex types have generators that operate without the use of series auxiliary ballast resistances. The importance of providing a proper form of direct current by specifically designed motor-generator sets for motion picture application cannot be over-emphasized. Modern highly efficient standard high intensity arcs of the focusing type, have high speed optics, are sensitive to control and therefore a really Stedy-power supply of direct current is a

prime necessity.

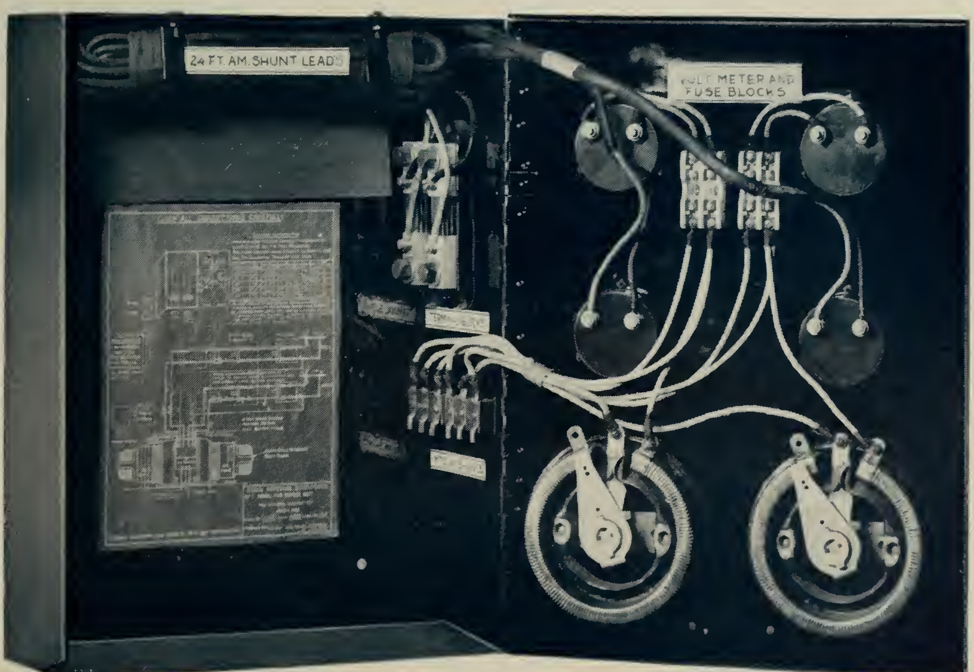
3. **Heavy overload capacity.** In this field no other kind of electrical equipment exceeds the motor-generator in its capacity to handle large temporary peak overloads, such as occur during arc striking. Even reasonable sustained overloads are handled without damage.

4. **Very good overall efficiency.** Well-designed and carefully manufactured motor-generators show a high ratio of output DC energy to input AC energy fully comparable to such ratios in other types of conversion equipment where the factor of dependability is not given the same consideration as the motor-generator. No sacrifice in efficiency is necessary to secure the other desirable characteristics obtained with the motor-generator.

5. **Low maintenance cost.** Except for occasional lubrication and probable annual generator brush replacement, the first cost of a motor-generator is usually the last cost. It is believed the records of any theatre equipment dealer will coincide with those of the theatre service companies which indicate the motor-generator set leads all other projection room equipment with a record of little trouble and low maintenance cost.

Fundamental Arc Characteristics

The carbon arc is an inherently unstable device, that is, it tends to go out unless auxiliary stabilizing means are externally provided. This comes about due to the fact



Interior view of control panel for duplex type multiple arc motor generators

that carbon, and the arc, exhibit that rarity in nature, a negative temperature coefficient of resistance. That is, the resistance to the flow of current *decreases* as the current tends to get larger. With most conductors the opposite is true. Stabilization is effected by connecting in series with the arc sufficient resistance of the usual kind (a "ballast" resistance) to compensate for the negative arc characteristic.

With some types of single arc rectifiers having relatively high internal impedance to the flow of current, this ballast resistance can be omitted.

The focusing type highly efficient arcs of the present day demand are extremely critical as well as being sensitive to voltage variation, therefore, any contributing factor to the stabilization of the arc is of importance.

The carbons are smaller and the current density per square millimeter of area greater with the Suprex type arcs than any other. The last lamp design to be marketed is the "One Kilowatt," which has a rated arc voltage of 27.5 with a working current of 40-42 amperes. The standard Suprex arcs operate within an arc voltage of 32-36 and a current range of 42-65 amperes. It is likely this current rating will be increased in post-war offerings.

For small installations using one kilowatt arcs where the low voltage arcs only are to be used, and where theatre size precludes the possibility of more light being needed at a later date, small and very efficient motor-generators having an output voltage of around 36 volts can be used. Where higher voltage arcs, such as spotlights, must also be operated, a very satisfactory and efficient unit consists of a Duplex Multiple motor-generator having one driving motor and two 36-volt generators, each operating one low-voltage lamp; the higher voltage arc is then operated from the two 36-volt generators connected in series through a ballast resistor to the 72-volt circuit.

Generator Terminal Voltage

For the standard Suprex lamps and multiple type motor-generators, the most efficient generator terminal voltage is about 42-45 volts. This is too low for the operation of spotlights, etc., however, and is also too low for best arc stability. As in the case of motor-generators for one kilowatt arcs, higher voltage arcs can be operated by selecting a Duplex multiple unit providing two 42-volt outputs which can be series connected for an 84 volt circuit, and 55 volt arcs operated with a proper ballast resistor in series on the 84 volt line.

Unless minimum first cost and maximum efficiency are the controlling factors, however, it is usually better to select a somewhat higher voltage motor-generator. For this service 60 volt units are recommended by almost all manufacturers. Spots and effect machine lamps can be operated economically, and the projection arc lamp controls will nearly always function better. The improved performance to be derived from better stabilizing ballast action can be seen from sample measurements made with a 36 volt, 50 ampere Suprex arc. With a 60 volt generator the change in arc current per one volt change in line or arc voltage was approximately 4%. Using a 42 volt generator, the change was over 14%, three and one-half times as great. This improved stability is important and well worth the small additional costs, for it provides a margin of safety to compensate for such defects in lamp operation as those caused by imperfectly operating arc controls, and their component parts, particularly the driving motor, disturbances to arc tail flame caused either by the revolving shutter of the projector mechanism or improperly dampered lamphouse flues or their connections.

Motor-generator Control Panels

Motor-generator control panels usually are of the dead face type consisting of a steel cabinet mounting on their covers and back connected field rheostats for the control of the generator voltage, a voltmeter to indicate the output generator voltage and an ammeter to indicate the total D.C. load.

Some types may be provided with a push button station to control the starting and stopping of the motor-generator—signal indicating lamps, suitable terminal blocks to facilitate connections to the external circuit wiring. Ammeters are usually provided with external shunts which can be placed in the switchboard to obviate the necessity for bringing heavy current wiring through the generator control panel solely for the purpose of this connection. Special type switchboards with single or double throw switches and bus bars are sometimes furnished with the generator control panel as special equipment.

Control panel for standard single-unit multiple type arc motor-generator

Selection of the proper rated Motor-Generator

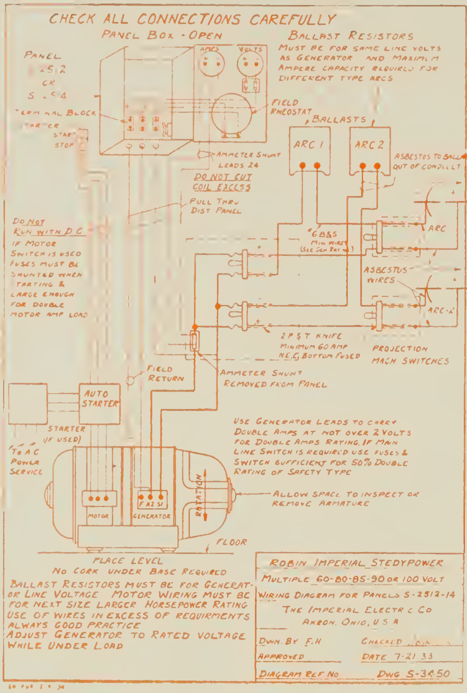
The explanatory information of preceding sections is also applicable under this heading and need not be repeated. As noted, the motor-generator voltage and ampere rating depends upon the number of arcs, the arc voltages and current, and the type of arc lamps to be powered simultaneously.

The following is concerned with other important considerations to be taken into account to determine the maximum kilowatt generator rating. It is this rating which principally determines the cost of the motor-generator.

The one general rule to follow is to select a machine of a voltage and ampere rating sufficient to provide capacity for the largest possible load the theatre may eventually have in operation and at one time.

Control panel for duplex type multiple arc motor-generators

This load can usually be determined with reasonable accuracy from consideration of theatre size, type of performances and probable future policies. It is wise, however, to recognize the industry trend toward increased screen size and illumination is only



temporarily delayed by the war and post-war developments may accelerate this trend.

Actual field experience has shown that under normal conditions the arc current for a given type of carbon trim and lamp is almost invariably stepped up to maximum shortly after the installation and as soon as the owner realizes what benefits and profits can be obtained from really clear, brilliant life-like reproductions, projected in a house lighted in the interior to balance eye fatigue. The late Mr. George Eastman and the writer have both pioneered to obtain this improvement over a long period of years.

Every exhibitor and person concerned with the installation of electrical apparatus should give very serious and earnest consideration to the subject of wiring and the selection of the proper rated generator. Motor-generators are renowned for the long years of satisfactory service, provided they are used in accordance with the nameplate rating and the manufacturer's recommendation.

Installation and wiring costs usually represent a considerable dollar investment, so it is smart and less expensive eventually to initially provide reserve capacity in both the wiring system and the generator unit rather than be forced at a later date to make expensive alterations or replacements because of a lack of foresight at the time of original purchase.

Motors and Motor-Generators

Proper Maintenance and Repair

By JAMES E. HUCKLEBERRY

It is a sad commentary indeed to say that the motors in all theatre equipment have usually been sadly neglected. Neglect can close a theatre not only for hours, but for days. To aid in the prevention of such admission losses is the aim of this article, and I hope that the suggestions made will be of some value to theatre owner, manager and projectionist.

First, I recommend that a complete survey be made of every point in the theatre where a motor might conceivably be in use. Sounds silly, I know, but it has often proven truly surprising to many an exhibitor to discover how many motors he has in the house. Here are a few places where motors are used—motor generator sets for arc lamp power supply; sound reproducer motors; rewind motors; curtain control motors; vacuum cleaner motors; ticket machines; cooling and heating system motors; sump pumps, fans, etc.

Once they are located, the name plates on each motor should be cleaned thoroughly and a record made of manufacturer's name, motor type, horse power, r.p.m., cycles, serial number of motor—in fact, every item of information that might be on that name plate. The name, address and telephone number of the manufacturer and his dealer will be helpful to have.

After you have this data, see your theatre equipment dealer and find out where you can obtain a "loaner" motor of each kind in the event of a breakdown that cannot be repaired by a member of the theatre staff. Motors can stand a lot of abuse, but some parts wear out faster than others and a spare set of such parts should be kept on hand.

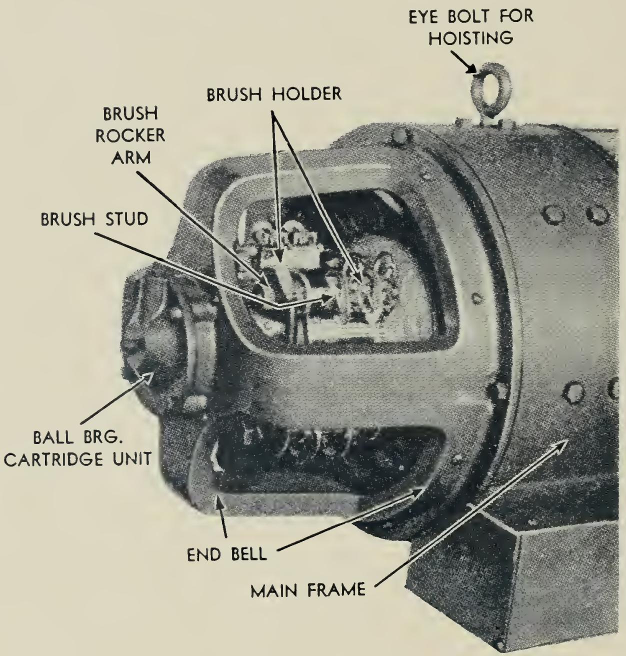
If your motors are old and have never been repaired, then it is desirable to immediately have your theatre equipment dealer make arrangements for an immediate overhaul of each and every one. This is particularly true if the motor is a component part of an obsolete sound system, arc lamp or air conditioning system.

Routine Inspection

If you are one of those individuals who have taken care of your motors, such action, of course, will not be necessary. But whether you have been careful or neglectful of the condition of motors, it is well to set up a regular inspection routine to prevent trouble before it occurs. Careful records of conditions and dates of each inspection should be kept, and repairs, lubrications and installation of new parts should be noted.

It is practically impossible to set down any hard and fast rules for the frequency of inspections, as they are best determined by the particular location and usage. In general, in motors and generators using oil bearings, the oil level should be checked once a week and renewed when necessary. Oil rings should be checked to see if they are turning freely. The temperature of the bearings and frame can be checked by feeling with the hand. Most motors and gen-

erators for theatre operation are designed on a basis of 40° C. temperature rise. This means that the temperature of the motor or generator should not be greater than 40° C. (72° F.) above the temperature of the room in which the equipment is operating. when changing brushes that they are of the exact type and grade specified by the manufacturer of your equipment. The writer, after many years of dealing with hundreds of motor and generator installations, and keeping exact cost records of



Sectional photo of motor

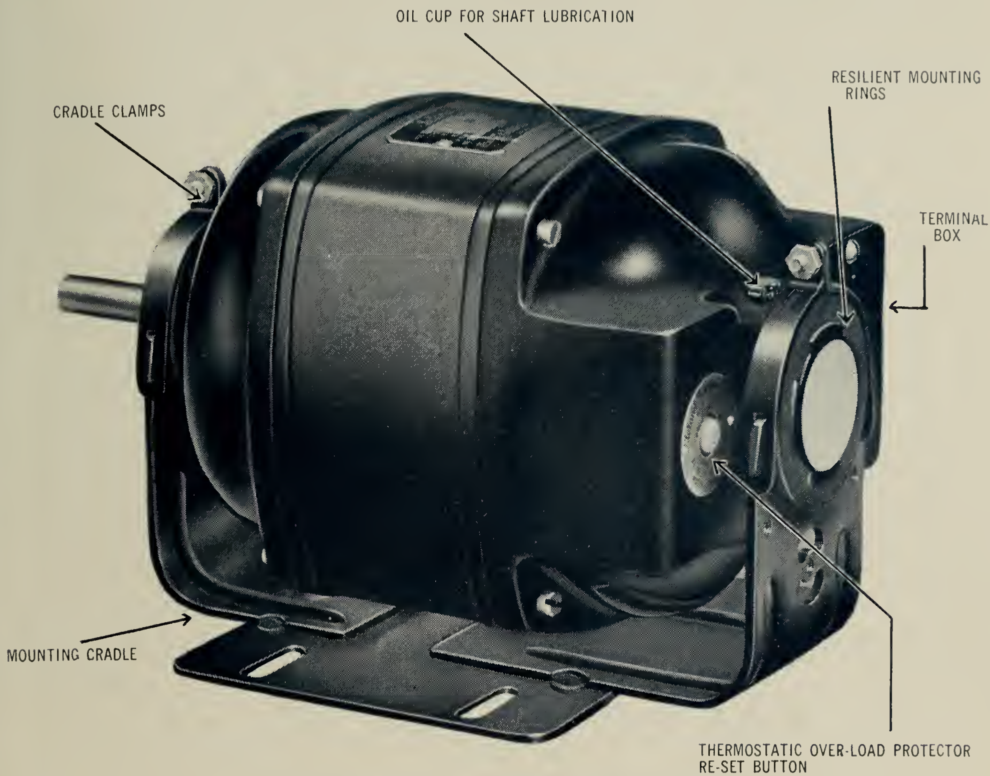
A motor or generator that is operating properly will feel warm to the touch, but not uncomfortably hot. Also, smell the air coming from the open machine. The fumes coming from over-heated insulation are unmistakable.

Once each month, brush-holders, brushes and brush pig-tails or shunts should be checked. Make sure that the brushes are of proper length for good operation, that they are seating properly on the commutator, and that the screws fastening the pig-tails to the brush-holders are tight. Make sure operations, has come to the conclusion that the use of any part in repairs other than those specified by the manufacturer, either because it is cheaper or for other reasons of false economy, is a very costly practice indeed. During the periodical check the motor should be blown out with compressed air. Air of more than fifty pounds of pressure per square inch should never be used; in fact, a medium sized hand bellows could be used just as well and with far less chance of damaging insulation.

Once each year the air gap (see section

on "Air Gaps") of the motor should be checked with a feeler gauge. Check the insulation resistance with a "meggar" (see section on "Insulation"). Check the line voltage under load with an accurate voltmeter, and the line current with an ammeter. The grease (unless of the sealed-in type) in ball and roller bearings should also be cleaned out and renewed at this time.

Every two years, where practical, the motor should be taken apart and cleaned. Inspect bearings for wear, see that all windings are tight, and that all loose wedges and bands are tightened or renewed before dipping the windings in insulating varnish and baking. In the absence of facilities for baking, a preparation known as Glyptol may be used, and as it is air drying and its insulation properties are very high, it is a very excellent substitute for dipping and baking.



Split phase motor with resilient base mounting. (Courtesy Leland Electric Co.)

Bearings

Bearings probably cause more motor and generator troubles and failures than any other cause. When we remember that they can be victims of poor foundations, loose fastening down, mis-alignment and dozens of other factors, this is not at all surprising. Also, they are subjected, in many cases, to just any lubricant that happens to be handy. The first requirement in any success-

ful bearing operation is proper lubrication. This entails no more bother than obtaining the manufacturer's lubrication specifications for the particular machine, and then living up to them to the letter. Absolute safe bearing operating temperature of bearings can be considered as 40° C. above room temperature. As stated before, this temperature feels comfortably warm to the hand. Assuming proper mechanical conditions and proper lubrication and assembly, any undue temperature rise should be investigated immediately, and measures taken for its correction.

Ball and roller bearings are becoming more frequent in usage, and carelessness in their maintenance is usually responsible for their failure. Again, the advice of the manufacturer should be followed regarding lubrication. Soda base soap greases are usually used on account of their high melting point and their general stability. Such greases, however, have one bad feature—they mix readily with water and tend to form an emulsion.

Ball and roller bearings in trouble can usually be detected by two signs, namely, heating and excess noise. Cracked, broken or nicked balls, rollers and races will cause the bearings to be destroyed rapidly. They can be detected by the clicking sounds that they make while the machine is in operation.

When the temperature of a ball or roller bearing rises to unsafe limits, look first for an overfilled bearing. Heating is always a symptom of an overfilled bearing, which is caused by the churning of the grease. A good general rule to follow in greasing of ball and roller bearings, in the absence of instructions by the manufacturer, is to fill the bearing from one-third to one-half full. Clean all old grease from bearings and housings at least once each year, and repack with new grease. Always protect new grease from dirt and dust.

Air Gaps

The air gap on a motor or generator is dependent upon two things—bearing maintenance and proper alignment of supporting brackets or pedestals. Alternating current motors are designed to operate with less air gap than D.C. motors or generators, and therefore are more critical. The air gap should be checked from the pulley or coupling end with a feeler gauge, taking four readings at 90 degree intervals—top, bottom and both sides. For motors A.C. 10 h.p. or less a minimum gap of .005 inch is desirable, while for larger motors .010 inch will be about right.

Couplings

The couplings on direct coupled motors and generators should have frequent and regular inspections. Faulty couplings, loose coupling bolts and improper alignment are all reflected in bearing troubles and excessive vibration. Make sure that all dowel or aligning pins are correctly placed, and that the faces of rigid couplings are touching evenly all the way around. The faces of the couplings should be checked with a feeler gauge after removal of the bolts. The motor position should be shifted to align coupling faces properly. Flexible couplings will operate under severe misaligning strains without trouble, but they should be as carefully aligned as a tight coupling. You will be more than repaid for your care in aligning by decreased wear and tear on pins, fingers, leather or composition discs, or whatever flexible member is used.

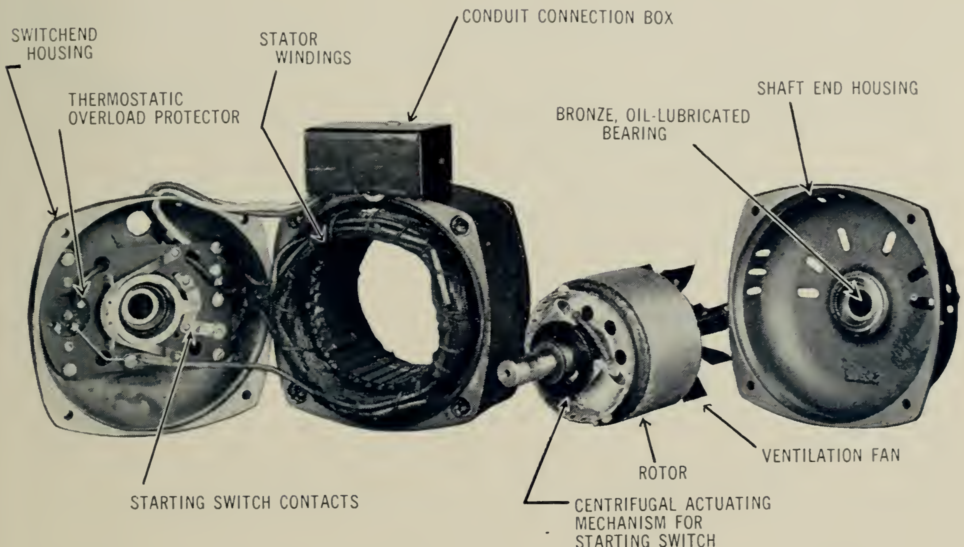
Insulation

With respect to insulation, a good thing to remember is that any motor is only as old as the condition of its insulation. Motors used in clean, well ventilated rooms of average temperature will operate indefinitely without deterioration of insulation, while motors in hot and dry or excessively moist locations deteriorate very rapidly. Insulation is important in that it separates the electrical parts from the mechanical parts of the motor and should be maintained as such.

The keeping of electrical equipment clean

and dry is very important. Dust, dirt and oil are the arch enemies of insulation and contribute greatly to its breakdown, and they also tend to raise operating temperatures above safe levels. Excessive dirt and dust can be blown out with air at low pressures, but should never be blasted out, as the dirt frequently contains abrasives that are liable to cut and wear insulations badly.

ment to read resistance to ground over a range from 10,000 ohms to infinity. While this instrument is too expensive to be included in the equipment of the average theatre, most power companies have them for the testing of their own equipment and they are usually willing to make arrangements to test their customers' equipment as a matter of policy.



Typical small single phase A.C. motor disassembled to show internal construction

Oil can be washed away with a neutral solvent such as oleum spirits or carbon tetrachloride. Always remember when using inflammable substances for cleaning to have the room well ventilated and equipment well grounded to guard against static sparks.

Do not paint windings with Glyptol or baking varnish until they are thoroughly clean. When baking in an oven, the temperature should be controlled at 115° C.

Insulation tests are made more to check the insulating condition rather than its quality. A very convenient instrument for this test is the 500 volt meggar, an instru-

The readings obtained are valuable only for purposes of comparison. A steady curve of readings over a period of time is good, while a steadily declining resistance to ground reading from time to time indicates insulation deterioration, and enables repairs to be made before a breakdown and while cost is comparatively low. A good safe rule to follow is that the insulation value should be one megohm (one million ohms) for each 1,000 volts of operating voltage, with one megohm as a minimum for any operating voltage.

Direct current motors and generators present their added brush holder and com-

mutator problems to the general maintenance picture. The direct current motor or generator has its heart in its armature. The main line current flows through the armature, and when the machine is overloaded it is always the armature that shows the first signs of trouble. When dismantling a D.C. motor or generator for overhauling or checking, always observe the following rules:

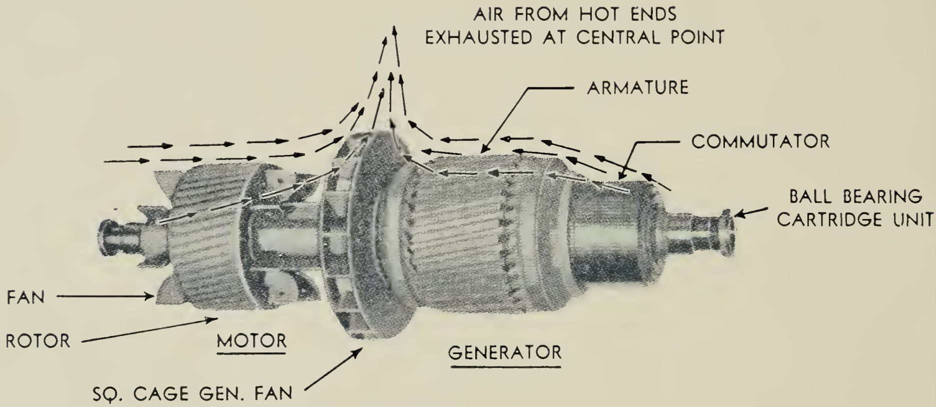


Photo diagram of motor generator

1. Never rest the weight of the armature on its commutator or coils.
2. Do not roll the armature on the floor, and when placing it on the floor, it should rest on several thicknesses of heavy paper. When an armature is rolled upon the floor a coil is liable to be injured, or the banding wires are liable to be nicked, causing them to break.
3. If at all possible, always support or lift an armature by its shaft.
4. Inspect all coils and see that all wedges are tight and that all band wires are tight.

If it becomes necessary to replace a band on an armature, be sure, as far as possible, to duplicate the original banding. The material, diameter of wire, and the width and position of the band must always be the same. An increase of band width or size will produce heating, and sometimes this will be great enough to melt the solder on the bands, thus causing them to loosen and come off.

When commutator bars are loose, they should be tightened only by an experienced workman. When the bars are tight, they will sound with a bell-like ring when struck lightly with a light hammer. Bars that give off a dull thudding sound when struck should be tightened at the front vee. This vee ring, due to its exposed position, is a general catch-all for dust and dirt. It should be carefully cleaned by washing with carbon tetrachloride or some other good cleaning fluid, and wrapped with light twine. It can then be painted with insulating enamel (Glyptol), and kept clean by wiping at frequent intervals.

Good Care Brings Returns

The brush rigging should be checked at frequent intervals, and should be changed whenever there is any appreciable wear on the inside of the brush boxes. Brushes must be fitted so as not to be so tight as to stick, or so loose as to chatter when the machine is running. Always make sure that

the brushes used are those specified by the manufacturer of the machine, and that they fit the commutator all along the face of the brush. The spring tension of the brushes should be uniform on all brushes. This tension can be measured by a small scale which may be purchased from any electrical supply house. A good tension, in the absence of more definite instructions from the manufacturer of the equipment, is 1½ lbs. per square inch of brush face surface. The brushes should be staggered in alternate pairs (every other arm) so as not to allow the surface of the commutator to become grooved. Shunts should be kept tight at all times and not allowed to burn or corrode.

When necessary to resurface a commutator it should always be done in a lathe or grinding jig. There are hand stones on the market for which great claims are made, but my experience has been that they are far from satisfactory. The only help they give is temporary and usually they only hasten the trip to the lathe. A true surface can only be made in a lathe or grinding jig.

Most commutators of today are undercut in the mica insulation between the bars. This undercutting will vary with different manufacturers, some using a V cut and some square. Regardless of the method used, this undercutting should be kept clean and about one sixteenth of an inch deep.

"Don't go to see that picture! It's so bad I had to sit through it three times to get my money's worth."

RECTIFIERS

Theatre Rectifiers

An Explanation of the Various Types

By HARRY H. STRONG
President, The Strong Electric Corporation

The incoming power supply to most theatres is necessarily alternating current, because alternating current affords the only feasible means of transmitting electrical power over long distances. However, modern projection arc lamps are fundamentally direct current equipment because the crater of a high intensity direct current arc is the only light source of sufficiently high intrinsic brilliance and concentration to provide satisfactory projection of motion pictures. Accordingly, it is necessary to employ some means of converting the incoming alternating current electricity to direct current for use in the projection arc lamp.

This changing of the current is accomplished through the use of some type of electrical conversion equipment, generally a rectifier or motor-generator set. Originally, generators were used quite universally for this conversion of current, but with the development of the tungar tube and copper oxide rectifier elements there has been a definite swing to rectifiers because of their lower original and operating costs, higher efficiency and stable operation, to say nothing of greater ease of installation, portability, and the elimination of moving parts.

As manufacturers of projection arc lamps, the Strong Electric Corporation has been interested in producing an economical electrical conversion equipment to supply direct current having the exact volt amperage characteristics necessary to assure a stable burning arc without the use of wasteful ballast resistors, as is necessary with the motor generator. Accordingly, we have taken advantage of the new developments in rectifier elements to develop a complete line of rectifiers for arcs of various capacities and for the various line voltages servicing the theatres.

Types of Rectifiers

The tube rectifier depends primarily on the valve action of a heated filament (cathode) and a cold anode sealed in a glass envelope arranged so that it will pass electricity in one direction only. Two or more of these rectifier tubes are connected in a transformer network so that a particularly smooth direct current is supplied to the arc when the rectifier is connected to an AC power circuit.

The complete rectifier consists mainly of an insulated type transformer provided with taps as required for the various power line voltages and an 8-point manually operated rotary switch for convenient adjustment of arc amperage.

Rectifiers of 40 amperes or less are generally built for use on single phase power lines. High capacity rectifiers up to 80 amperes are designed for three phase power operation.

The thirty ampere rectifier for use with low intensity arc is supplied for use on single phase AC circuits, and employs two 15-ampere tubes connected for full wave rectifications.

Rectifiers up to 50 ampere capacity may be supplied for either single or three phase power circuits, and these rectifiers employ four 15-ampere tubes.

The larger capacity 6-tube rectifiers up to 80 amperes are supplied for 3-phase power circuit operation because these heavy current loads are better supplied over 3-phase AC power lines and because of the smoother DC output current delivered by 6 tubes when they are connected for full

A Strong Utility Rectifier, supplied for use on single phase AC Circuits

wave rectification on 3 phase circuits.

Rectifier Components

The tube type rectifier is comprised mainly of a special transformer for changing the alternating current voltage to a potential suitable for operating the arc, a radial switch for regulating the arc current to the desired number of amperes, the rectifier tubes, a substantial housing, and the necessary sockets, lead wires, etc.

A Strong Rectifier, showing ventilation ducts

The transformer is of the modified core type, designed to possess constant current characteristics, thus allowing commercial fluctuations of line voltage without affecting the stability of the arc. The primary and secondary coils are separate and are effectively insulated from each other. This allows only the low voltage necessary to operate the arc to enter the lamphouse.

Ventilation by means of air draughts through the large unobstructed ducts, underneath and adjacent to the sides of the transformer, past the tubes, and through the perforated metal top and sides of the housing, effectively dissipate the heat, with the result that the rectifier operates at particularly low temperatures.

Simple To Install

The installation of Strong rectifiers is particularly simple, as they are furnished in single lamp capacities to suit individual needs. This makes it possible to build units small enough to be placed in a corner, or on the floor directly under the projector, where they may be readily connected to the present wiring by means of lead wires which are furnished with the rectifiers.

The smaller theatre which employs the one-kilowatt lamp of low capacity generally has only single-phase power available and accordingly we have developed a one kilowatt 4 tube single-phase rectifier to meet this condition.

Copper Oxide Rectifiers

The production of a new means of rectification employing copper oxide elements has resulted in the development of a complete new line of copper oxide rectifiers particularly well suited to supplying DC power to the new low voltage high intensity arc.

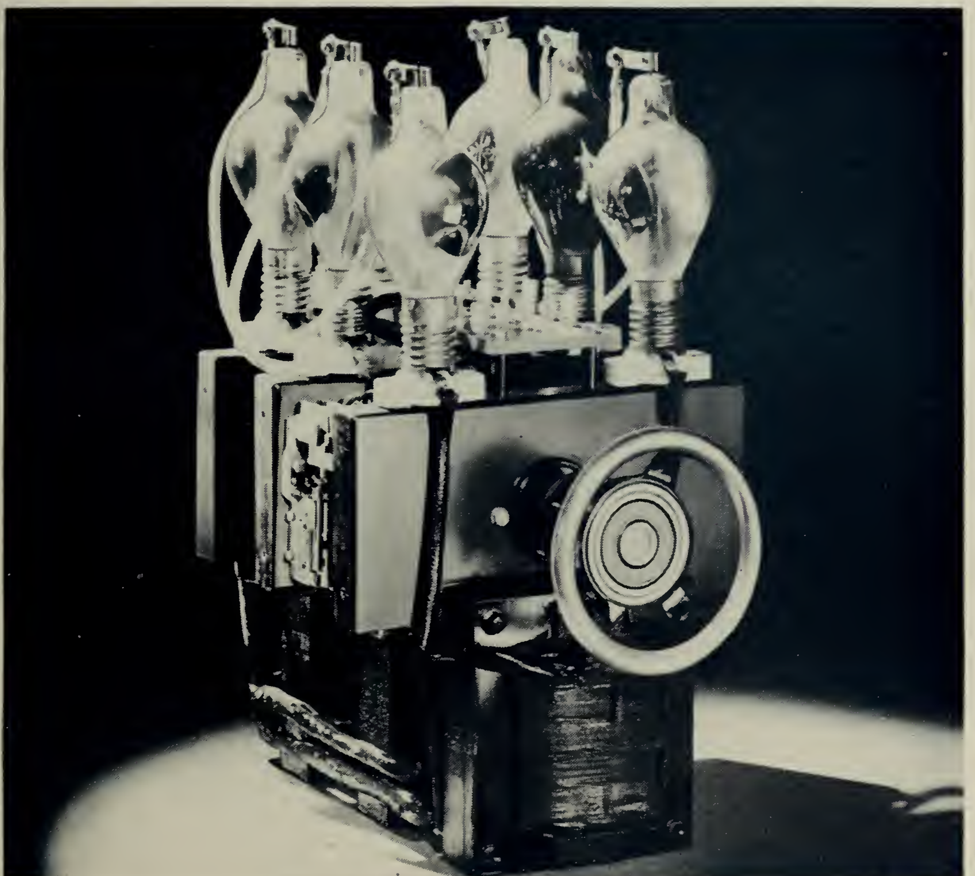
The principle of the copper oxide recti-

fier is similar to that of the "cat's whisker" detector of crystal radio days, in which certain dissimilar metallic elements in contact possess the peculiar property of passing electricity freely in one direction, but offer very high resistance when the current flows in the opposite direction.

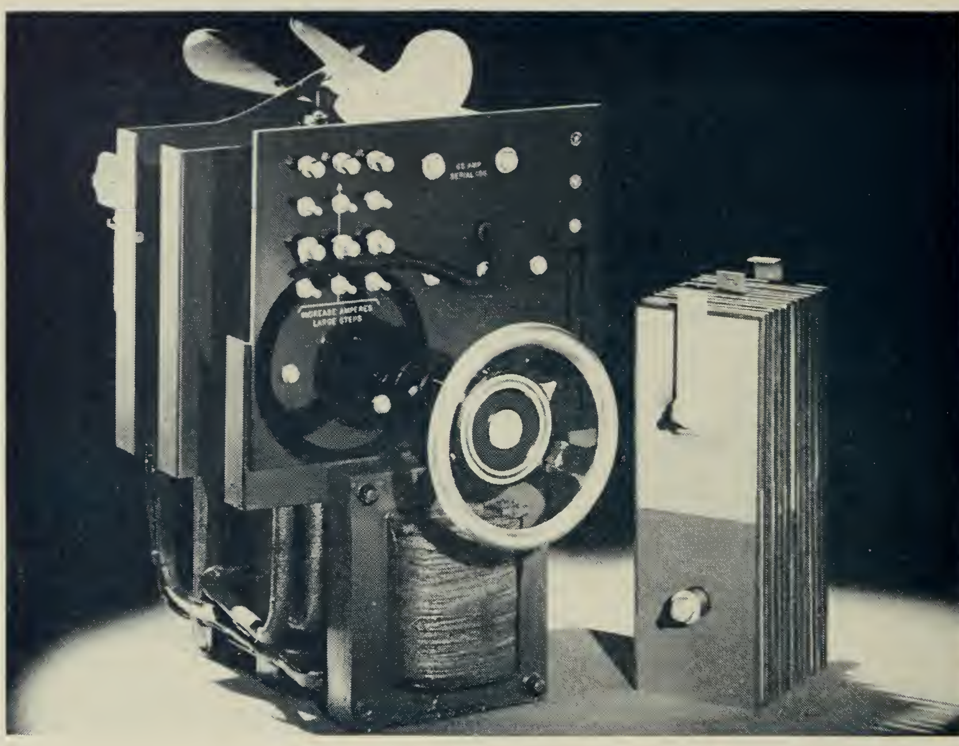
In the instance of this copper oxide rectifier, the elements employed are pure copper and copper oxide. In practice these rectified elements are manufactured sheets of pure copper upon which has been formed a layer of copper oxide.

The actual manufacture of the copper oxide elements follows the procedure of heating sheets of pure copper to a cherry red, then transferring the still hot copper sheets into an atmosphere of oxygen, wherein the outer surface of the copper is transformed into a layer of the oxide of copper.

In utilizing this principle, the oxide



Arrangement of tubes in the larger capacity six tube rectifier employed for 3-phase power circuit operation



Copper oxide rectifier, with oxide coated plates

coated plates are connected in an electrical network so that the AC line power supply emerges from the rectifiers as direct current.

Since copper oxide rectification is by molecular action, that is, no physical change takes place, the useful life of the rectifier is extremely long, providing it is not prematurely aged by heating as the result of overload. Accordingly, the copper oxide rectifier is provided with forced ventilation to assure low operating temperature.

Comparison of Advantages

Weighing the advantages of the various types of rectification, the motor generator is stable in operation but comparatively high in first cost and relatively wasteful of current. It is large and heavy, requires periodic inspection and repairs, and is often noisy.

The tube type rectifier is most efficient, low in first cost, simple in construction and operation, and requires little attention. While there may be some physiological objection to the thought of tube replacement, modern tube life is entirely satisfactory, and the tubes are quickly replaced at low cost. All of these advantages probably account for the fact that more theatres employ tube rectifiers than all other types of rectification combined.

In the instance of copper oxide rectifiers, they have won early acceptance due principally to the publicity given their high efficiency and long life; however, the last claim cannot as yet be substantiated, due to the fact that the copper oxide rectifier

has not had sufficient field service to experience the test of time. Another disadvantage of the copper oxide rectifier is the expense of replacing worn-out copper oxide elements.

Trends favoring various types of rectification differ geographically, probably as the result of individual sales efforts favoring one type of equipment by local sales organizations.

"Don't you know that you can't operate a projector without a license?"
"I found out that I couldn't operate it, but I didn't know the reason why."

DRIVES

Chains, Belts or Gears?

Sound reproducers and projector mechanisms, and sound reproducers and take-ups of various makes and models, are coupled together by either chains, belts or gears, while some projector mechanisms even use a combination of sprockets and chains instead of interlocking gears.

Each of the three methods of coupling has its champions among theatre equipment manufacturers, projectionists and service engineers, so that an examination of all methods may aid in determining which, if any, method is superior to the others.

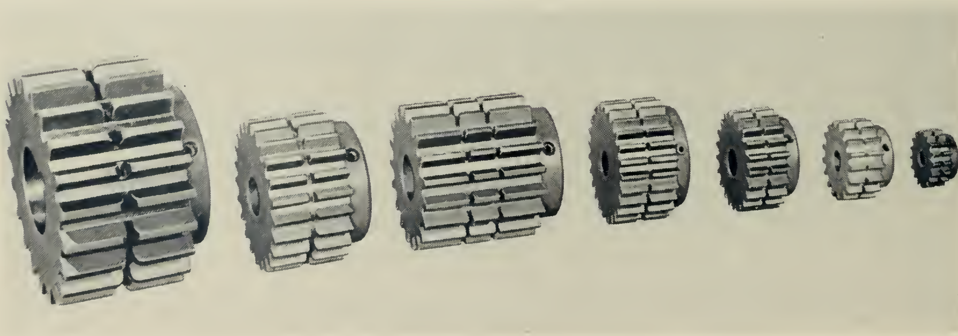
Types of Chains

Chains fall roughly into two classifications—the so-called "silent chain" and the "roller chain" (the latter usually termed a bicycle chain). Experience indicates that the "silent chain" is superior to the "bicycle chain" type for use in projection room equipment.

"Silent chains," have obvious advantages over roller chains. Chief among them are longer life, more silent performance, no tendency to slip, greater flexibility to cushion shocks and but slight tendency to stretch.

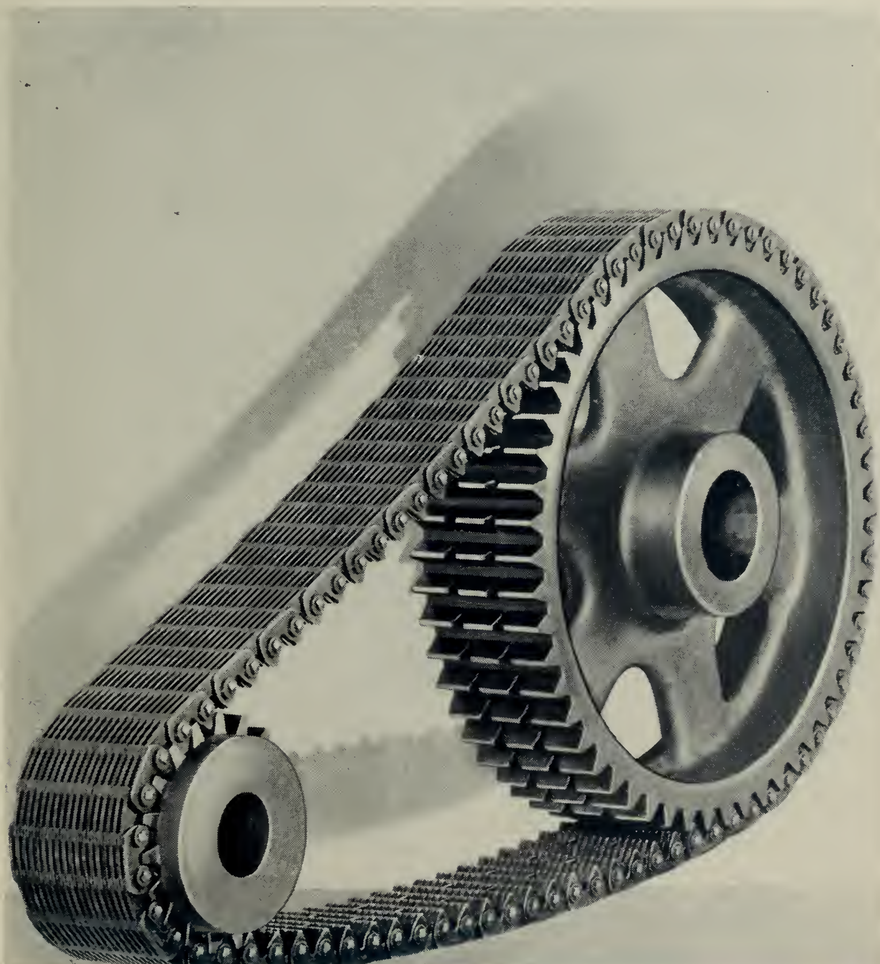
The long wearing quality of "silent chains" is well indicated by the fact that in several thousand installations of Motiograph 7500 sound reproducers made in the last six years, there have been no sprocket or chain replacements as a result of breakage or wear.

The so-called "bicycle chains" have proven satisfactory as a method of coupling sound reproducer and take-up, as the load



Typical sprockets employed in silent chains

is relatively light. As a substitute for a gear train in a projector, however, the "bicycle chain" has proven unsatisfactory because of its tendency to stretch, which, of course, has the same effect on machine performance as a gear train with considerable back-lash. The use of "silent chains" in projector mechanisms themselves has not had sufficient trial to determine their value as a substitute for a gear train, but as none of the projector manufacturers who have a large number of theatre installations use such chains within projector mechanisms, it would seem that any such use is not likely to become general.



A silent chain drive

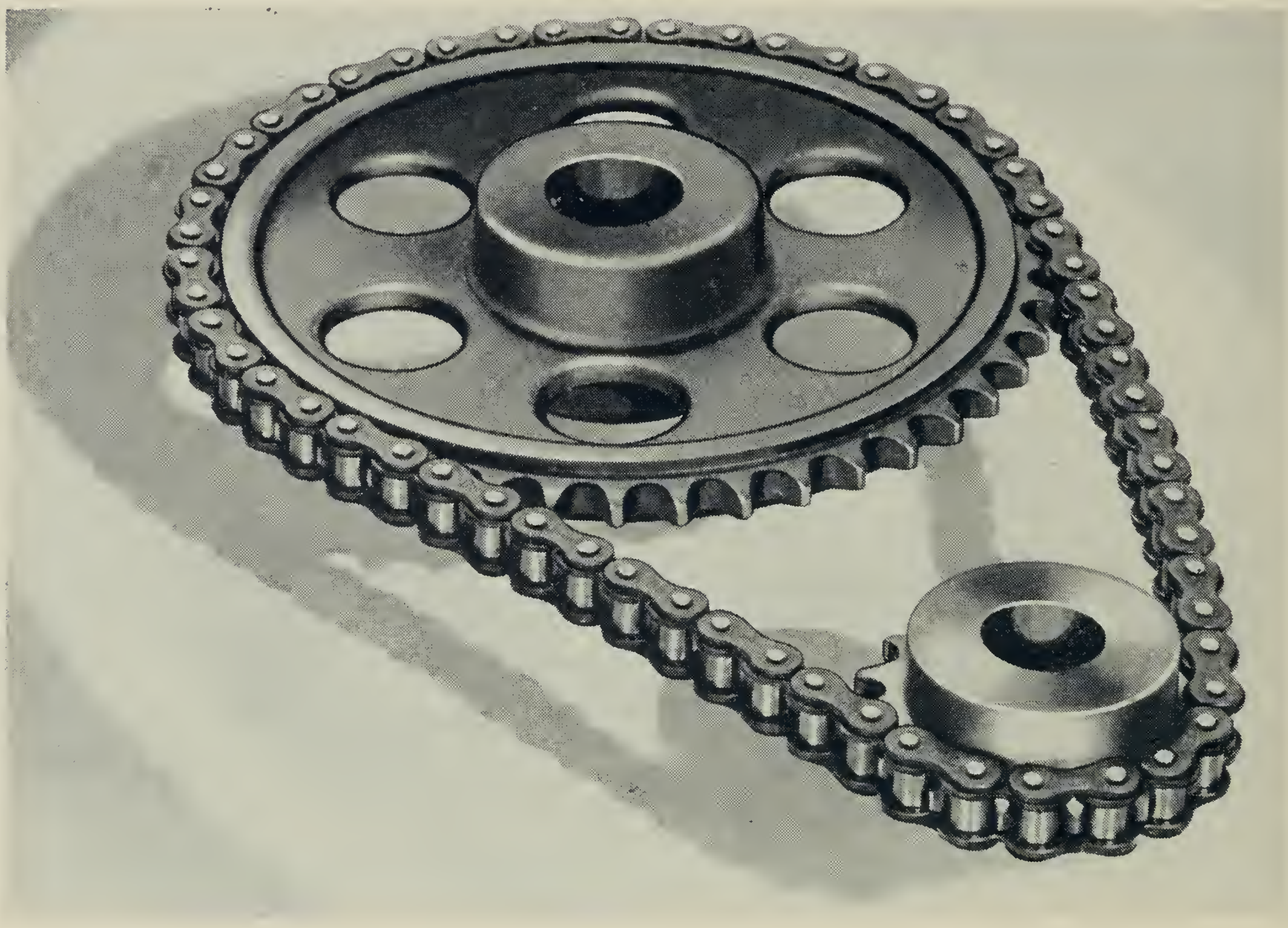
Trend to Silent Chains

There is unquestionably a trend in all

industry to couple machinery to its power source by means of "silent chains" instead of gears or round or flat belts.

Many projectionists have had trouble with belt slippage and breakage in operation, and consequently there has been built up an antipathy against belts of all kinds. Invariably, however, this dislike can be traced to the old sewing-machine type of round leather belt indifferently clipped together. (They will perform reasonably well, however, if kept very tight over their associated pulleys).

Round leather belts have not proven overly satisfactory because they are often too long at original or replacement installation, and they have a tendency to stretch which causes frequent slippage. Projection equipment is usually over-oiled, and oil and leather just don't get along, which, of course, means frequent replacement of such belts.



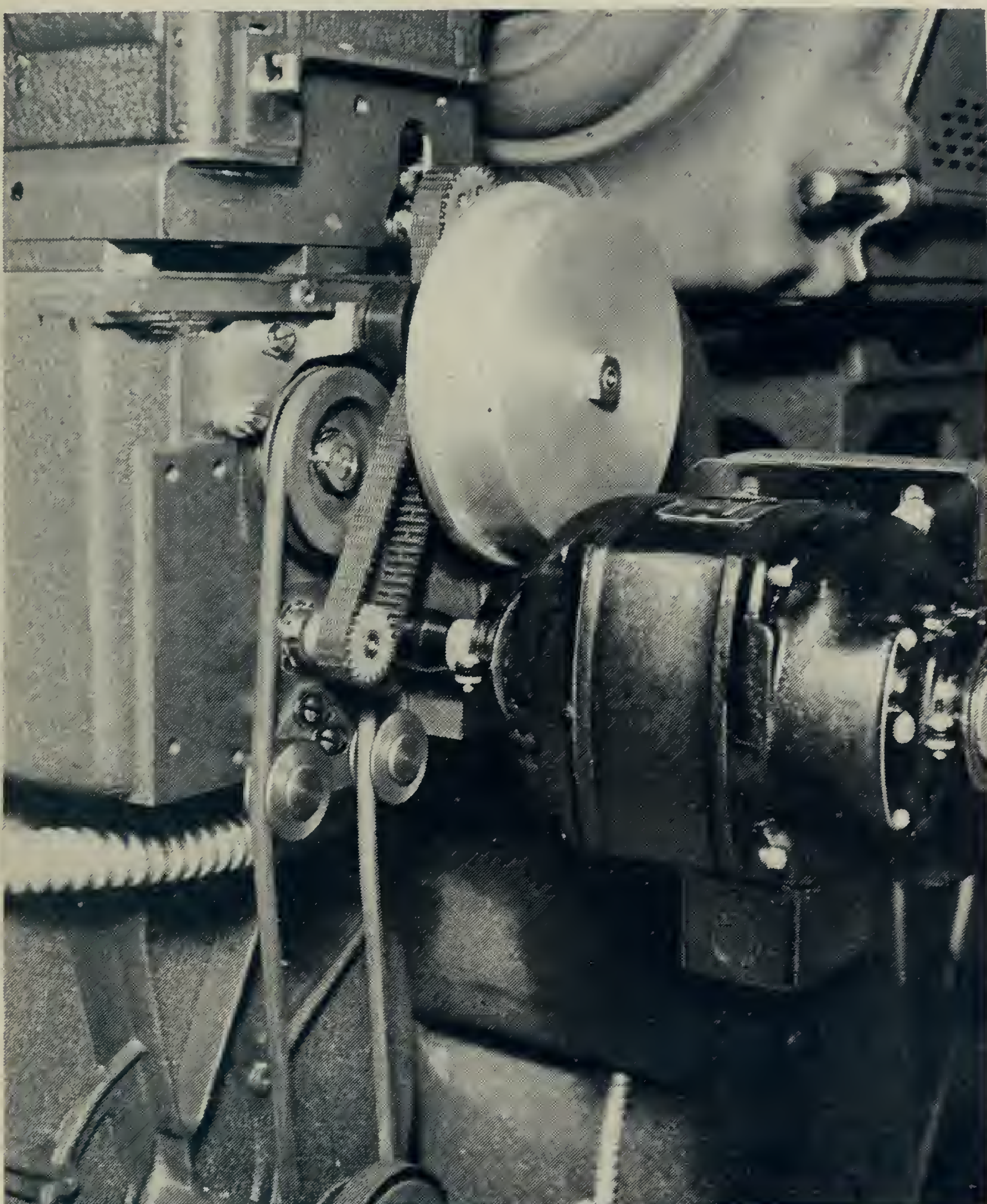
A roller or "bicycle" chain drive

V Belts

The V belt type has been most satisfactory in all applications in projection equipment, but even the V belt has found some enemies. Reported difficulties with the use of V belts, however, usually can be traced to the use of V belts with pulleys designed for operation with round belts. When V belts are utilized with pulleys

actually designed for use with V belts, it has been found that they will work exceptionally well in power transmission or in driving take-ups. V belts well fitted to associated pulleys are even more silent in operation than so-called "silent chains" and are much less costly than both silent and bicycle type chains.

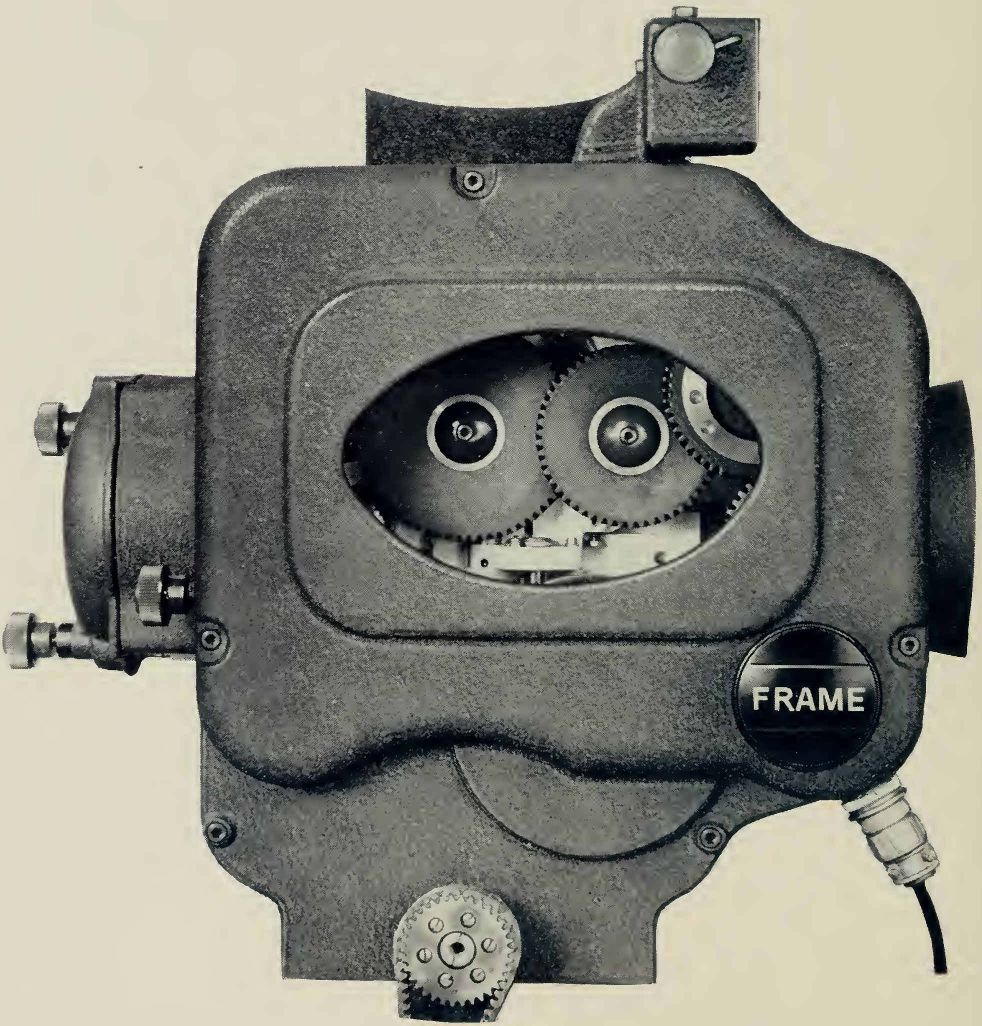
The more common types of V belts in use today are made something like a tough casing of an automobile tire. Heavy low-stretch cords impregnated with rubber compound form their center, with a two-ply rubberized fabric cover on all sides. V belts grip their associated pulleys by side pressure, which brings about firm gripping



Drive side of Motiograph-Mirrophonic 7500 Reproducer, showing the silent chain coupling of the reproducer and the projector mechanism, as well as the round leather belt coupling the reproducer and the lower magazine take-up

with virtually no slippage. Belts of this type not only give superior performance, but far outwear the round leather type. Though there is no marked tendency to slip, there is sufficient flexibility to V belts to absorb the starting shock of the motors.

The war brought a new development into the construction of V belts, which should add materially to their life, and forever remove any tendency to stretch. This new development is the utilization of fine steel wires, surrounded by a rubber compound as a center for the V belt, the center then being covered with a two or more ply rubberized fabric. Some of the synthetic rubbers which will undoubtedly be utilized are also unbelievably resistant to the effects of oil.



The gear side of the Motiograph "AA," with guard removed to show drive

The Sound Reproducer

An Explanation of Its Functions

By R. T. VAN NIMAN

Chief Sound Engineer, Motiograph

In modern equipment, the sound reproducer is mounted just below the projector mechanism, since the sound for the scene before the light source is located on the film twenty frames (approximately 14½ inches) in advance of that scene. Its major function is to translate the sound track's photographic record of the original sound into a varying electrical current. By means of the sound system's amplification apparatus, this current is used to control much stronger currents, which are then converted into faithful copies of the original sound by the theatre sound system's loudspeaker equipment.

Basis of Sound Reproduction

This sound producing function is accomplished by passing the sound track through a very thin beam of light produced by a small exciter lamp shining through a narrow slit, and exactly focused on the sound track with small lenses. The original steady beam of light is varied in intensity by the alternating light and dark areas comprising the sound track, and the resulting fluctuating beam of light is then passed on by means of lenses, prisms or mirrors to the photoelectric cell.

In most modern types of sound reproducers this process may be observed by removing the cover from the photoelectric cell and watching the spot of light on its plate while film is passing through the reproducer. In those reproducers having the film carried by a rotating drum at the point where the light beam strikes the sound track, a still further understanding of the process may be gained by watching the sound track as it passes the light beam while listening to the sound from the monitor loudspeaker. In this manner it is possible to observe that the *loudness* of the reproduced sound depends upon the degree of contrast between the light and dark sound track areas, and that the *pitch* or frequency of the sound depends upon the rate at which the track alternately hinders or permits light from the exciter lamp to pass on to the photocell. In effect, the moving sound track acts as a shutter which causes the beam of light passing through it to vary in a manner corresponding to the sound waves which were associated with the projected scene originally. It is still necessary, however, to convert these light variations into variations in electrical currents, and then to convert these current variations

into sound waves by means of loudspeakers before there is actually any sound to hear.

Photoelectric Cells

The first of these conversions is accomplished in the photoelectric cell of the sound reproducer. Photoelectric cells as used in sound reproducers are electronic devices which change their internal resistance to the flow of electrical currents through them when exposed to light. The photocell may be thought of as a light-operated electrical valve. If a lot of light falls on the cell, a lot of current flows through it, while if less light falls on the cell, the current falls off. These current variations therefore faithfully follow the variations in the amount of light reaching the cell. The exact processes through which the photocell brings about these results are somewhat complex, involving rather advanced principles of electrical physics, and no attempt will be made to go into them in this article. For our purposes it must suffice to say that from the photocell onward we have our record of the original sound waves in the form of a varying light current.

R. T. Van Niman

Unfortunately, this current is exceedingly weak, in the order of a few millionths of an ampere (the conventional unit for measuring electrical currents). It is not strong enough to operate loudspeakers, and circuits carrying it must be very carefully shielded and insulated to prevent loss of the current or the pickup of noise or hum from other electrical circuits and apparata in the projection room. To secure a current which varies in the same manner, but is strong enough to operate loudspeakers, the weak photocell current is used as a control source for vacuum tube amplifiers capable of producing the required stronger current. The functions and operation of these devices, and of loudspeakers, will be covered in subsequent articles, since the present discussion is limited to the function and operation of the sound reproducer.

In addition to the major function of producing a varying electrical current corresponding to the photographic sound record on the film, most modern sound reproducers perform several other mechanical functions as well in the complete sound motion picture projection apparatus. They provide a support for the projector mechanism, and the lower film magazine is usually fastened to the under side of the sound reproducer. It is customary, also, to associate the driving motor for the projector with the sound reproducer, and to couple the reproducer to the projector mechanism by means of gears or silent link chains, since it is obviously necessary that they run at exactly the same rate of film speed. In many modern reproducers the power needed to operate the film takeup mechanism in the lower magazine is supplied by means of belts or chains from one of the reproducer shafts.

Uniformity of Film Speed

In the foregoing discussion many important details regarding the function and operation of the sound reproducer have been intentionally passed over in order to give a clearer overall picture of the device. film speed variation at this point will cause the pitch to be unsteady—rapid variations such as might be caused by the film sticking to worn or rough sprocket teeth result in "flutter," and the sound is rough and gargly. Slower variations such as those

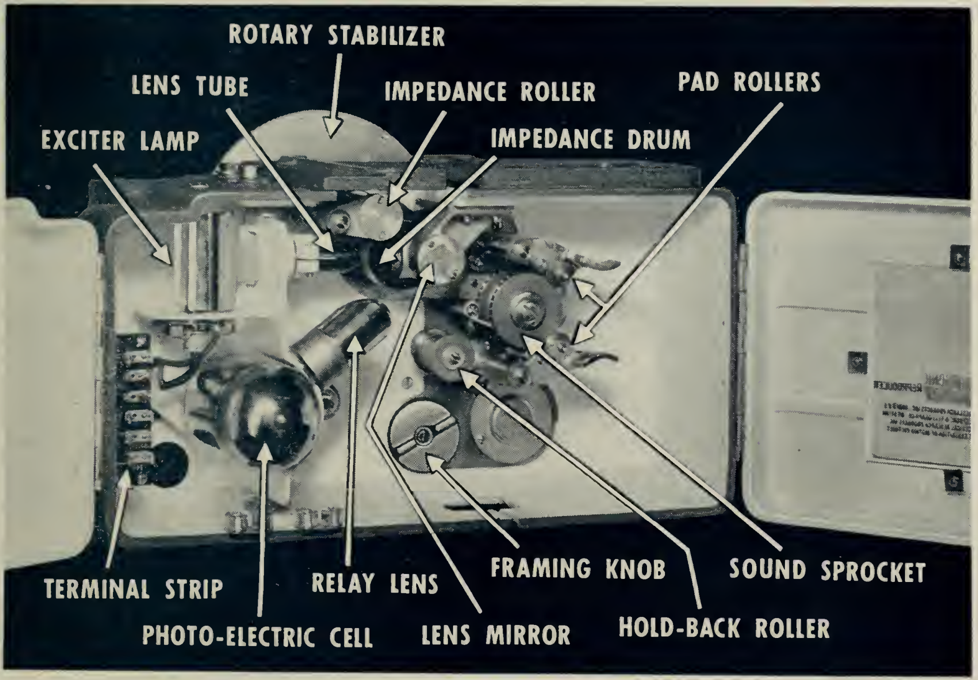


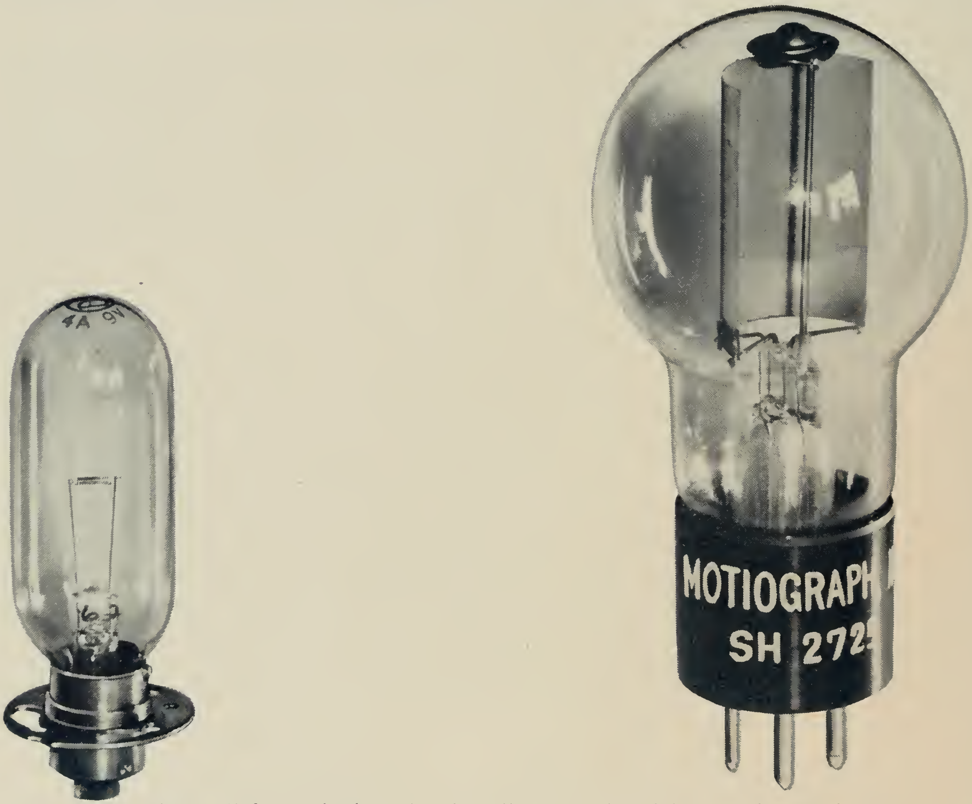
Photo-diagram of Motiograph-Mirrophonic De Luxe SH-7500 Rotary Stabilizer Reproducer, indicating various components mentioned in this article

With the basic principles and operation established, a few of these can now be touched upon to round out the discussion.

Since the pitch or frequency of the reproduced sound depends upon the rate at which the sound track varies the intensity of the steady beam of light from the exciter lamp, it will be evident that the film motion at the point where this beam passes through the sound track must be as nearly uniform as possible if the reproduced sound is to be exactly like the original. Any resulting from drive motor speed variations, or defects in mechanical filtering devices, cause "drift" or "wow," since they occur at a slow enough rate for the ear to perceive the individual departures from steady pitch.

Early reproducers depended upon heavy flywheels attached to the sound sprocket shaft for the required smoothing or filtering action, and the film was supported at the track scanning point by being pulled over either straight or curved polished

metal supports called "apertures" because they contained an opening at the appropriate point for the light to pass through on its way to the photocell. While the performance obtained with this arrangement was very good, particularly where all the components were carefully and ruggedly made, and were kept in good adjustment, a considerably different and improved film moving and mechanical filtering system is used in the more modern reproducers.



Exciter lamp (left) and photoelectric cell, as employed in sound reproducers.

The Rotary Stabilizer

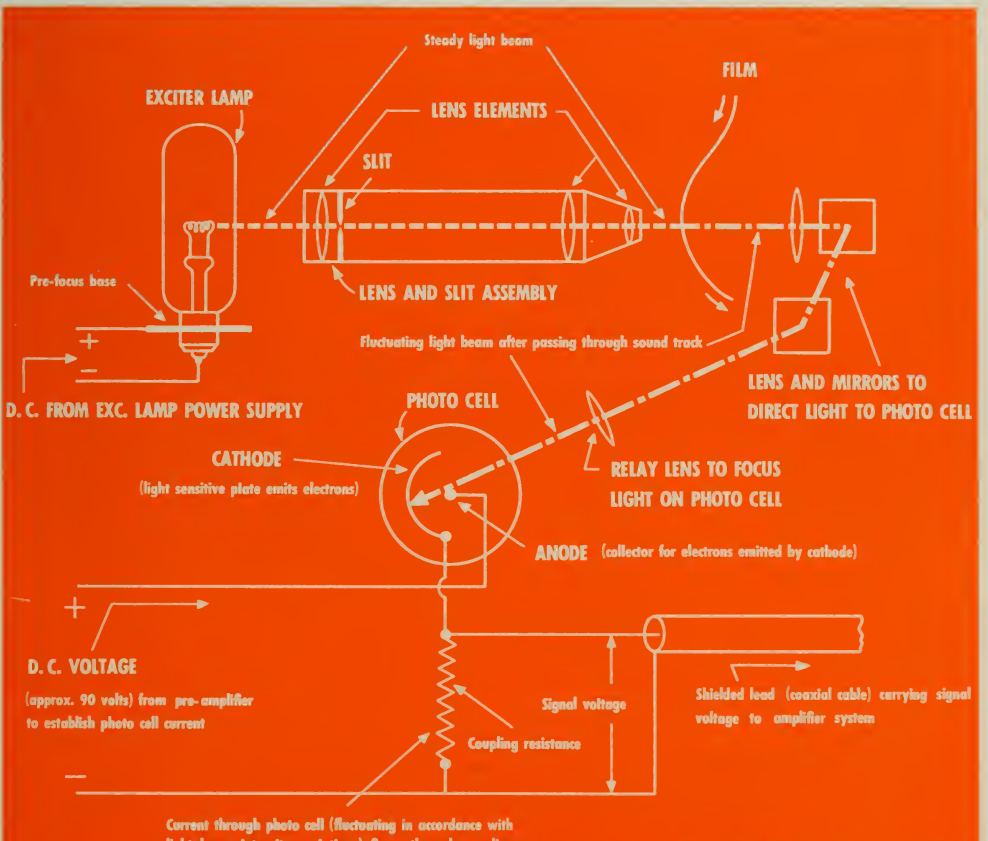
In modern systems the film is supported at the scanning point by a smooth faced drum affixed to a freely rotating shaft carrying on its opposite end a medium size flywheel. The flywheel is hollow, and inside it, supported by ball bearings, is a heavy inner flywheel coupled to the outer shell only by means of a suitable liquid.

Associated with the film supporting drum there is usually a freely running auxiliary padded roller to hold the film firmly against the drum and to provide lateral guiding action to properly align the sound track with the beam of light from the exciter lamp. The whole assembly, including the auxiliary roller, is rotated by the film itself, and thus has no mechanical connection to other moving parts of the reproducer except by way of the film. In threading film into the reproducer, sufficient slack is allowed to permit the looseness on either side of the film carrying drum to isolate the film at the scanning point from nearly all of the disturbances caused by sprocket teeth entering and leav-

ing the film perforations. The absence of direct mechanical connection effectively isolates the rotation of the film carrying drum from disturbances originating in other mechanical parts of the reproducer, and this, plus the smoothing and stabilizing action of the compound flywheel, results in an evenness of motion at the scanning point entirely adequate for excellent reproduction of the recorded sound. Film moving systems of this kind are variously known as "rotary stabilizer" or "kinetic scanner" types. The Motiograph Model SH-7500 Mirrophonic Reproducer, and the Northern Electric Company TA-7500 Reproducer incorporate this type of film moving system, and the exceptional performance of these reproducers is evidence of the effectiveness of the system.

Control of Light Beam

In an early paragraph it was noted that the pitch or frequency of the sound depends upon the rate at which the moving sound track interrupts the beam of light from the exciter lamp to the photocell. Since the film moves at a constant speed of ninety feet per minute, or one and one-half feet per second, this means that for high pitched sound the alternating light and dark areas

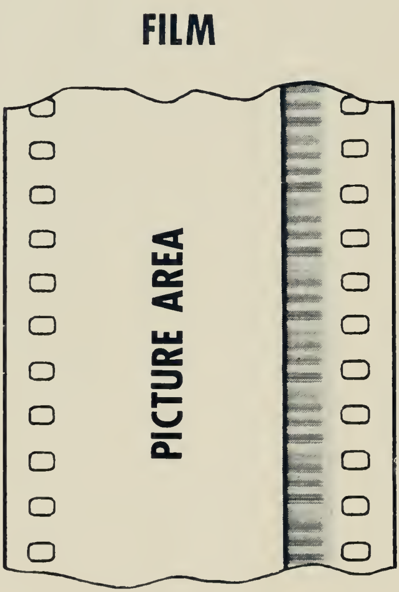


SCHEMATIC DIAGRAM OF OPTICAL AND ELECTRICAL SYSTEMS IN SH-7500 MIRROPHONIC REPRODUCER

in the sound track must be very close together. Therefore, if the beam of light is to be varied exactly in accordance with the variations photographed on the sound track, the beam must be no thicker than the most closely spaced light and dark areas in the sound track.

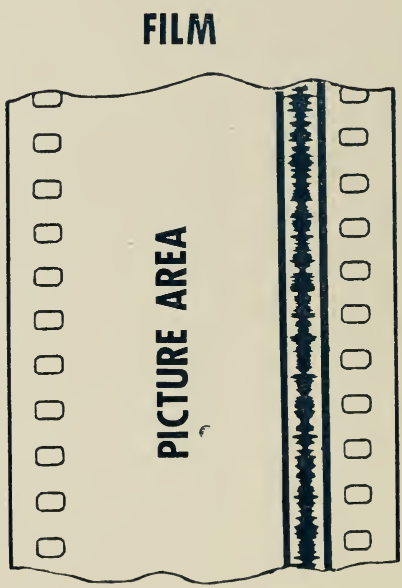
The thin beam of light can be produced in various ways. One optical system used in many old style reproducers started off with an exciter lamp having a single fine wire as a filament. The actual image of this filament itself was focused on the sound track, reduced in size by special lenses mounted in a small barrel. The more modern reproducers use an optical system somewhat less likely to be affected by imperfections in exciter lamp structure and sagging of the lamp filament with age. In these the lamp filament is a fairly heavy coiled spring. Light from this source strongly illuminates a very narrow knife-edge slit assembly usually located within the same barrel which supports the associated lenses for focusing an image of this illuminated slit on the film sound track. With this arrangement the lenses and slit can be sealed against the harmful effects of dirt and oil, and since the dimensions of the light beam are established by the fixed slit, even gross defects in exciter lamp structure have little effect on the sound quality.

Some idea as to the thinness of the light beam necessary for good reproduction of the higher pitched sounds may be gained from the fact that the edges of the slit through which the beam passes are only about one one-thousandth of an inch apart, and the various lenses reduce the thickness of the slit image focused on the sound



Variable density sound track.

One of the two basic types of film sound tracks. The amount of light reaching the photo cell from the exciter lamp is varied by the density of the track.



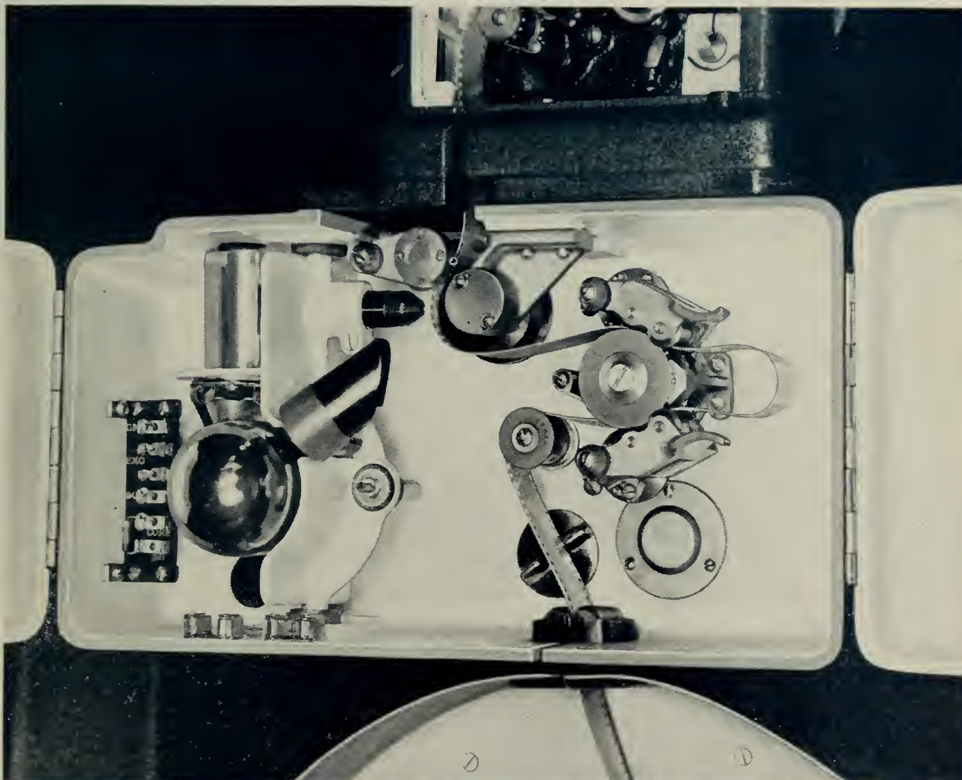
Variable area sound track.

The amount of light is varied by the changing relationship of the opaque and clear areas of the sound track.

There are a number of modifications of the two basic types of sound tracks shown.

track still further.

Optical systems for use with rotary stabilizer type film moving systems also include suitable masks inside the slit and lens assembly (commonly called "slit lens," "lens tube," "optical unit," etc.) to limit the width of the beam to the amount which will just adequately cover the width of the sound track. If the beam is too wide, or if the track is poorly aligned with the beam, some of the light will pass through either the sprocket holes of the film or the black cross lines which mark off the individual picture frames. If this stray light, which varies in intensity as each sprocket hole or frame line goes by, reaches the photocell, very disturbing noises in the reproduced sound will be heard. In older types of reproducers, where the film was pulled over a fixed support at the scanning point, the width limiting function was frequently taken care of by making the hole or aperture in this support just wide enough to pass the desired light through to the photocell.



Motiograph-Mirrophonic De Luxe SH-7500 Reproducer, showing proper threading of film.

Direct Current Preferable

Throughout this discussion the beam of light from the exciter lamp has been referred to as "steady," that is to say, con-

stant in intensity until after the time it passes through the moving sound track. Unfortunately, it can only be so if the electric current flowing through the exciter lamp filament to heat it to incandescence is likewise steady. If this current fluctuates in strength, the filament temperature and therefore the amount of light it produces also vary, and if these variations take place at a rate within the range of vibrations the ear can hear, an audible hum will be reproduced in the sound system output along with the wanted sounds.

For various reasons which do not concern us in the present discussion, the electric power supply in the great majority of localities is of the alternating current variety—that. is, the currents in circuits connected to these supplies flow first in one direction, then decrease to zero, and then flow in the opposite direction, with this process repeated many times per second. In the case of the 60 cycle power supplies common in the United States, there are 60 such reversals each second. When current of this type is used to heat the filaments of reproducer exciter lamps, the filament thus heats and cools, not 60 times per second, but 120 times per second, for the direction in which the current flows makes no difference in the amount of heat, and consequently in the amount of light produced.

Fortunately, this heating and cooling effect is not pronounced, particularly if the exciter lamp filament is made heavy and rugged so that considerable heat energy is stored to maintain the temperature when the current falls to zero. Many low cost sound systems do use alternating current for exciter lamp operation with reasonably satisfactory results, but virtually all of the better quality systems employ auxiliary devices, such as rectifiers or motor-generators, to change the alternating current power supply to the steady direct variety which flows always in the same direction. When this type of current is used to heat the exciter lamp's filament, the light beam can truly be called "steady," and there is practically no hum in the sound, even when the full beam reaches the photocell.

Photocell Voltage

The present discussion may be closed—and a groundwork laid for subsequent articles on amplifiers—by a brief consideration of the commonly used electrical circuits associated with the photocell of the sound reproducer. To establish a current through the photocell it is necessary to connect it with a source of electrical potential or voltage of the order of ninety volts. In the old days, this voltage was obtained from the familiar radio "B" batteries, since it must be absolutely free from alternating voltages of any kind if hum and noise pickup is to be avoided. With the advent of better designed amplifiers using well filtered rectifier type power supplies, it became possible to supply the needed photocell voltage directly from the amplifier circuits, and all modern sound systems are arranged in this manner. Connections are made so that the weak current which flows through the photocell also flows through some sort of a coupling device. This may be a suitable transformer which will pass on to the amplifier system small electrical voltages varying in magnitude in just the same manner as does the weak photocell current when the cell's internal resistance is changed by the varying light beam falling on its plate, or such voltages (commonly referred to as "signal voltages") may be developed by causing the photocell current to flow through a simple coupling resistance. The varying photocell current causes the voltage across this coupling resistance to change in exactly the same manner, and this voltage can then be used to control the action of the series of amplifiers needed to produce currents sufficiently strong to operate loudspeakers.

Theatre Amplifiers

I. Circuit and Electronic Tube Principles

By R. T. VAN NIMAN

As the subject of amplifiers is far too lengthy to be covered in a single article, we shall begin by discussing a few of the elementary electrical circuit principles and electronic tube principles essential to an understanding of how amplifiers function.

Electric Currents

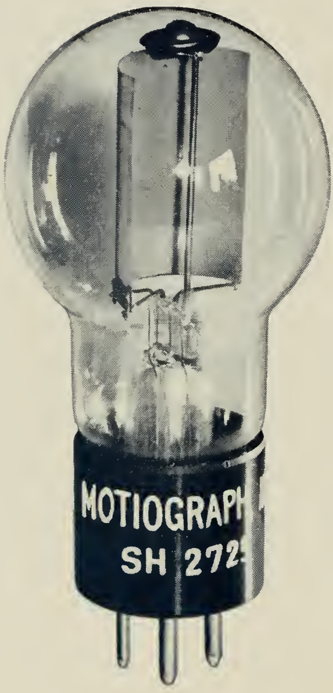
Electric currents are the motion of electrons, the elementary electrical particles which are the basis for all kinds of matter in our physical universe. In materials which are good conductors of currents the electrons are thought of as being relatively free to move; in non-conductors, or insulators, they are more firmly held in the electron groups constituting the atoms and molecules of the particular substance, and it is hence difficult to establish an electrical current through these materials. Inside electronic tubes, currents consist of streams of free electrons moving between and through the various internal structures known as the "elements" of the tube.

Moving currents of electrons always encounter some resistance to their flow in much the same manner that water moving through a pipe is impeded by friction between the water particles and between water and pipe. As in the case of the moving fluid, some of the energy represented by the current is converted into heat energy. If the material through which the current flows happens to be a poor electrical conductor, a great deal of heat may be produced.

Electrical Units

One of the basic facts about electrical circuits is that no current flow can be set up unless there is a difference of electrical potential, or voltage, along the circuit. This quantity roughly corresponds to "pressure" in fluids, and the fluid rate of flow corresponds to the size of the electrical current flow through the conductors making up the circuit. Electrical pressures are measured in units called "volts," and the rates of flow are measured in units called "amperes." The electrical power represented by a given current flow is measured in other units called "watts." Since power is broadly the ability to do

work, it will be evident that for any particular power we may have a small current at high pressure or voltage, or a large current at some lower value of voltage. As a matter of fact, in a circuit where the current flow remains steady (a "direct" current circuit) the power in watts is exactly equal to the product of the voltage and of the current measured in amperes.



Photoelectric cell as employed in sound reproducers.

One other electrical unit, and its relationship to the others just mentioned, must be discussed. This is the electrical unit of resistance to the flow of the electron stream, the "ohm." In many respects there is a remarkable correspondence between electrical resistance and the friction which is present in all kinds of mechanical apparatus. As was mentioned in a preceding paragraph, it opposes the current flow, and in so doing, converts part of the electrical energy into heat energy just as mechanical friction converts some of the kinetic energy represented by moving objects into heat.

The relationship between electrical resistance and the voltage and current in an electrical circuit is expressed by Ohm's Law, which states that in all circuits, or parts of circuits, the amount of current flowing is directly proportional to the amount of electrical pressure or voltage which is present, and is inversely proportional (that is, decreases as resistance increases) to the resistance present in the circuit or part of a circuit. This statement is strictly true for direct current circuits where the current flow does not fluctuate in either magnitude or direction, and is also true in alternating current circuits if the term "resistance" is broadened to include several effects which appear only when the current flow is not constant in amount and direction. The statement can be turned around and inside out to produce the equally true, and very useful one, which states that in any circuit, or part of a circuit, the voltage which appears across the terminals of a resistance is directly proportional to both the magnitude of the current flowing through the resistance and to the value of the resistance measured in ohms.

Electronic Tubes

Electronic tubes control the flow of electric current in a circuit much as a valve controls the flow of water in a pipe. As is evident from the diagrams, they get the electron flow outside the boundaries of the conductor so that it is enormously more subject to control action. The action is extremely rapid, approaching the speed of light, and also extremely sensitive, so that very small amounts of energy can be used to control relatively very large currents inside the tubes. In some tubes the electron flow is influenced by light falling upon one of the tube elements—these are the

photoelectric cells used in sound reproducers. Amplifier tubes have elements called grids to control the electronic action, and rectifier tubes function because tubes are fundamentally incapable of passing current except in the direction where the electron flow is from the tube cathode to its anode. All tubes must have terminals for connections to external circuits, and glass or metal envelopes from which the air can be exhausted to produce the conditions necessary for the establishment of the electron flow, and to prevent the metal parts from burning, or oxidizing when heated.

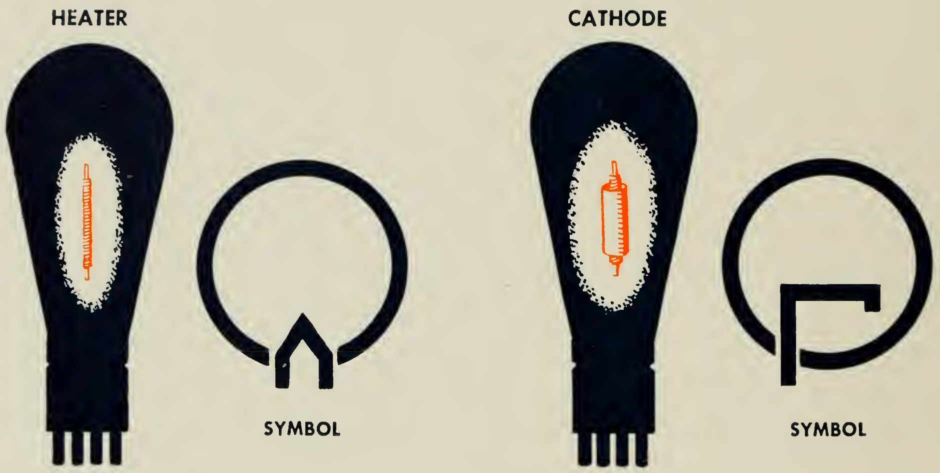
Rectifier-type Electronic Tubes

The simplest type of electronic tube usually encountered in motion picture sound equipment is the two element kind used for the conversion of alternating current to the direct variety needed at various places in the equipment. One of the elements (the "cathode") is a structure either heated directly by passing a current through it, or heated indirectly by being placed close to an auxiliary heating coil (the "heater"). The cathode is made from one of the many materials which emit veritable clouds of electrons under the influence of heat. Near this element is placed another in the form of a conducting plate or a cylinder surrounding the first element. Now, if a source of voltage is connected to the two elements, current will flow through the tube and the external circuit so long as the potential of the plate with respect to the cathode (the electron emitting structure) is maintained at some positive value, for the electrons, which have a negative charge by nature, are continuously attracted to the positively charged plate. If the plate potential becomes negative, the electron stream is repelled back to the cathode, and no current flows. In other words, the device acts as an electrical valve which permits current to flow in one direction only. If the plate voltage with respect to the cathode alternates between positive and negative values, current flows only during the intervals when the voltage is positive.

By using two of these rectifier tubes, or one tube containing two sets of elements, it is possible to arrange external circuits so that the resulting two pulsating, but uni-directional currents are combined into one relatively steady current. By means of electrical devices called filters the pulsations can be smoothed out so that for all practical purposes the current becomes identical to the direct variety, and hence suitable for all of the uses which would otherwise require the use of storage or dry

The electronic tube breaks the conductor and leaves an open space across which the electrons must pass.

batteries. The power units used in Motiograph and others of the better motion picture sound systems for reproducer exciter lamp and loudspeaker unit field operation are rectifier-filter combinations of this sort, and all amplifier systems include them to supply the direct currents and potentials needed for the proper functioning of the various amplifier tube circuits.



The heater (left) and the cathode, with their respective symbols.

Electronic Tubes as Amplifiers

Amplifier tubes operate in a quite different manner than rectifier tubes, though they also have a heated cathode to emit a stream of electrons and a plate element to collect them. In these tubes, however, the plate is continuously maintained at a positive potential with respect to the cathode by an external D.C. voltage source. They differ, moreover, in having in addition to a cathode and a plate element one or more wire grid-like structures interposed in the path of the electron stream between the cathode and the plate.

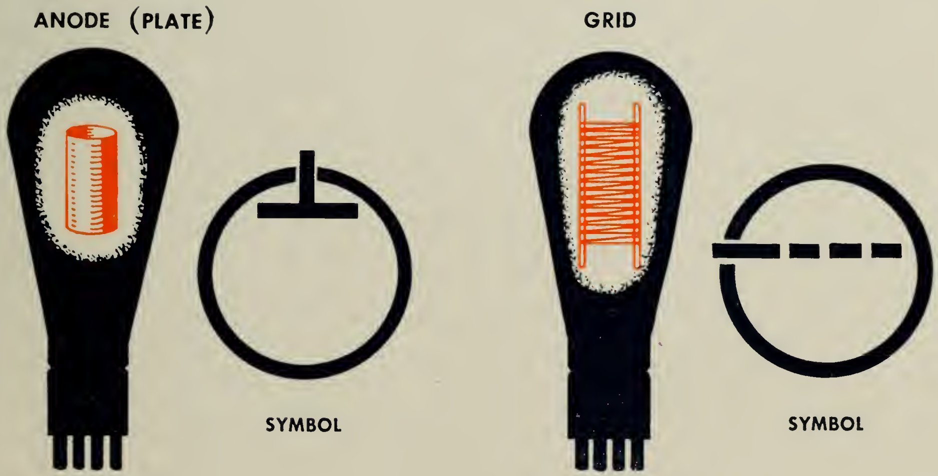
These grid structures, and particularly the one closest to the cathode, have the unique property of being able to radically affect the electron stream if their potentials with respect to the cathode are varied only slightly. This is the basic reason why the electronic tube can be used as an amplifying device; a very small alternating voltage applied between the control grid and the cathode will cause proportionately very large changes in the magnitude of the electron stream (usually called the "plate current"), and within certain limits established by the tube characteristics and external circuit conditions, these plate current variations will be exact copies of the variations in the grid voltage. The total plate current may be considered to be a combination of the steady current which would flow if the grid voltage stayed at its average value, and an alternating component caused by the effect of the alternating grid voltage on the electron stream. It is, of course, the alternating component which is of value, and there are various means for using it either directly or to develop a voltage which can be used to control other amplifier stages where the required amplification is greater than can conveniently be realized

in a single tube.

Other Circuit Elements

In addition to electronic tubes, amplifier circuits contain four major types of electrical apparatus, resistors, condensers, inductive reactors (commonly called "choke coils" or "retard coils") and transformers. Resistors are merely lumped quantities of some material having considerable resistance to the flow of current, such as carbon, certain metals and alloys, and various kinds of compounds. As used in audio amplifiers for motion picture sound systems, they are characterized by having substantially the same resistance to the flow of both alternating and direct currents, and they range in value from just a few ohms to several million ohms ("megohms") resistance. In circuit positions where little power is involved, resistors can be very small in physical dimensions; in other positions where power is greater, resistors may be quite large in order to dissipate the heat resulting from the current flow.

The other three types of apparatus have to do with alternating current circuits, or with direct current circuits carrying alternating components such as the filter and electronic tube circuits previously mentioned. Inductive reactors and transformers involve electromagnetic as well as electrical principles, and they will hence be considered together.



The anode or plate, and a typical grid.

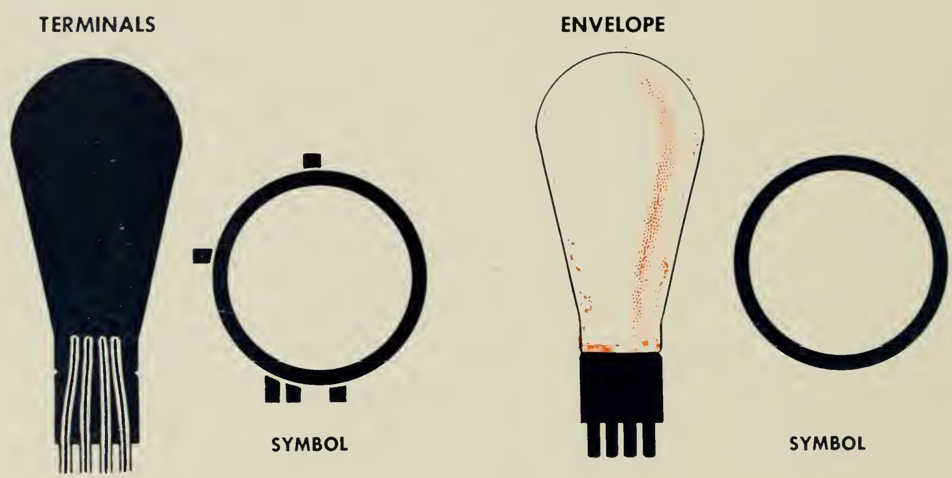
How Condensers Operate

About the easiest way to gain some understanding of the action of condensers in electrical circuits is to compare the condenser to a partitioned box connected into a water pipe line. The partition may be considered to be made from stretched rubber sheeting, and it thus prevents the continuous flow of water through the pipe line. It does not, however, prevent the water from surging back and forth in the line, for the partition will bulge whenever the pressure on one side is greater than on the other. If the pressure is continuous on one side, water flows into the box until the bulging partition exerts a back pressure

equal to that in the line. The larger the box, the more water must flow in to cause the back pressure to equal that in the line.

Electrical condensers operate in much the same manner. They consist of metal plates or sheets separated by some kind of an insulating medium such as air, waxed paper or mica. There can be no continuous flow of current through the device because of the presence of this insulating medium. If an electrical potential is applied across the plates, however, there will be an electron flow onto one plate and off the other until the resulting electrical charge caused by the accumulating electrons exerts a back potential equal to that applied. If the applied potential is now reversed in direction or polarity, the electron flow reverses, and the condenser charges up in the opposite direction. It may thus be seen that the condenser permits the flow of alternating currents in the circuit in which it is connected, but prevents the flow of continuous or direct currents.

The capacity of a condenser for storing up electrical charges is measured by an electrical unit called a "farad," and depends both upon the area of the plates and inversely upon the thickness of the insulating material which separates them. The farad is a very large unit, and condensers used in sound equipment are hence usually rated in microfarads, or millionths of a farad. The quality and thickness of the insulating material determine the amount of electrical pressure, or voltage, the condenser will withstand without sparking over between the plates, and condenser ratings, therefore, usually specify this voltage. For example, the main filter condensers in Motiograph's new type 7505-A Amplifiers have two eight microfarad sections per unit, each rated for use in 450 volt circuits. The actual circuit voltage is only 350 volts, so it is apparent that the amplifier design allows for a very liberal margin for safety.



The terminals and the envelope of the electronic tube.

Impedance and Reactance

The impedance a condenser offers to the flow of alternating current through it depends upon the capacity of the condenser

and upon the frequency of the current alternations. The term "impedance" includes the effects of the ordinary electrical resistance encountered in all conductors, and also the effect of another quantity called "reactance" which appears only in alternating current circuits. Some idea of the physical significance of these terms may be gained by going back to the water pipe analogy and making the unlikely assumption that there is some good reason for having the water rushing back and forth through the pipe and the partitioned box. It will be seen that if the box is large and if the partition is capable of stretching a considerable distance in each direction, the surging water currents will not be greatly impeded by the presence of the box in the line. If the box is small, or if the partition is relatively stiff, the surges in each direction will be limited in magnitude, and the box may be said to offer considerable impedance to the flow of the current surges. For a box of fixed characteristics this impedance will be less if the surges take place rapidly, for at a more rapid rate there will be a greater volume of water per unit of time going into and out of the box. This limiting effect, or "reactance," causes no loss of the energy represented by the moving water, but merely limits the magnitudes of the surges. There is, of course, still the energy loss caused by the friction of the water against the sides of the box, and loss caused by internal friction in the stretching partition. The total impedance offered by the box to the water currents is a combination of these energy losses and the limiting effect, or reactance.

Relative Effects of Currents

This analogy holds reasonably well for condensers in alternating current electrical circuits. If the condenser capacity is large, or if for a condenser of certain capacity the frequency of the alternating current is relatively high, the impedance of the condenser to the flow of the current will be relatively low, and the alternating current in the circuit may be nearly the same as if the condenser were not present. Direct currents, however, will of course be blocked off by the presence of the condenser. For condensers of relatively low capacity in circuits carrying alternating currents of low frequency, the impedance may be very large so that the resulting current through the condenser mav be very much limited in magnitude. As in the case of the water analogy, the impedance is made up of the energy losses caused by resistance in the conducting plates of the condenser and losses due to electrical strain in the insulating medium between them, in combination with the reactance effects resulting from the inability of the plates to accommodate indefinitely large electron flows onto and off the plates. Both the resistive losses and the capacity reactance are measured in ohms, and impedances are there-

The heater heats the cathode (left), which then gives off electrons.

fore also stated in ohms.

The fundamental properties of condensers are exceedingly useful in amplifier circuits, for they permit the separation of direct currents from alternating currents, and the variation of impedance with frequency allows circuits to be arranged which will permit currents of certain frequencies to flow while others of different frequency are greatly limited. The extensive frequency response equalizing facilities in the Motiograph MA-7505-A Amplifier are examples of the latter type of condenser application, and these facilities permit the amplifier performance to be exactly adjusted to suit auditorium acoustical conditions.

Electromagnetism

Electrical currents are always accompanied by strained or stressed conditions in the region through which the current flows. This field of stress exhibits the same characteristics, and in fact is identical to the field surrounding magnets. For convenience in thinking about such fields, it is customary to regard them as made up of imaginary lines of force something on the order of map contour lines, since along each such line the stress is assumed to be equal in intensity. The area in which the stress is present is called a magnetic field. Steady currents are accompanied by equally steady fields; alternating currents have magnetic fields which vary in intensity and direction of force in accordance with the current intensity and direction variations. Conductors placed in the region of a *changing* magnetic field have induced in them an electrical potential which may cause a current to flow if there is a suitable continuous circuit associated with the conductor; this is true also of a conductor through which a current is flowing to produce a magnetic field, and the induced potential is such as would produce a current in the opposite direction to that of the original current. Magnetic fields represent stored energy and they are capable of doing work just as a stretched spring represents stored potential energy.

When positively charged (left) the anode attracts electrons; when negatively charged (right) it has no attraction.

Physical substances differ radically in the ease with which magnetic fields can be established within and through them, and there is one family of substances, the ferrous (derived from iron) metals, so susceptible to the establishment of magnetic fields that they are universally used to confine and direct the magnetic lines of force in wanted directions. The lines of force pass through and are not hindered by nonmagnetic materials, which in general are also poor electrical conductors such as air, glass, wood, bakelite, etc.

Inductive Reactors

Strictly speaking, the term "reactor" can be applied to either a coil or condenser, since condensers produce reactance in circuits in which they are connected just as does a coiled conductor, but the term is ordinarily applied only to pieces of apparatus consisting of a coiled conductor, and particularly to such an arrangement having a core of iron or other magnetic material to confine and intensify the magnetic field. Coiling causes the individual fields around each unit length of the conductor to add up, and since the magnetic core still further intensifies and directs the field around all of the turns, a current in one of these unit lengths will induce potentials in all the other unit lengths making up the coil. The magnetic effects are thus very much more pronounced than they would be if the conductor were stretched out straight, or if the core of magnetic material were not present.

Such a device connected into a direct current circuit does not hinder the flow of current, once it is established, other than by means of the DC resistance of the conductor. It opposes the establishment of the current originally because the potentials induced in the conductor by its own changing magnetic field are always opposite in polarity to the potential which is trying to establish the current. It also opposes any diminution of the current after it is once flowing, since the potentials induced by the collapsing magnetic field are always such as to prolong the current flow which set up in the field. This property of opposing changes in the flow of current is called "inductance," and it is measured in units called "henries." In the case of a single coil or conductor the word is qualified by being called "self-inductance," and in cases where the potentials are induced in some associated coil or conductor, the property is known as "mutual inductance."

Symbols for triode amplifier tube (left) and gas-filled half-wave rectifier tube.

It may easily be seen that alternating currents, which are constantly changing in both magnitude and direction, will be strongly opposed by inductive reactors, and that the faster the alternations take place, the more opposition there will be. This opposition is called "inductive reactance" to distinguish it from the type associated with condensers, and its value in ohms is proportional to the frequency of the current and to the amount of inductance the reactor has. The latter depends upon various factors such as the number of turns of conductor in the coil, the shape of the coil, the nature of the core material, and the value of the current flowing through it. As in the case of condensers, the total impedance offered by such devices to the flow of alter-

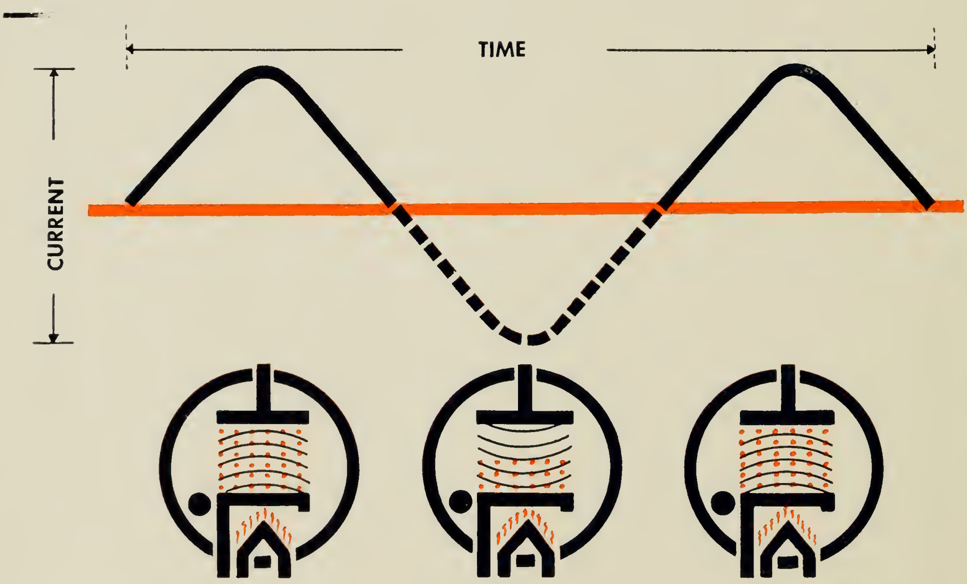
nating current is a combination of the DC resistance of the conductor and of the inductive reactance; the only energy loss they produce is due to the DC resistance, for the energy used in establishing the magnetic field is all returned to the circuit when the field collapses.

Inductive reactors are principally used in amplifiers to smooth out the irregularities in uni-directional, but pulsating, currents produced by the rectifier tubes. Since the reactance varies with frequency, they are also useful in arranging circuits which will respond differently to AC potentials of differing frequencies, and in combination with condensers and resistors, they are the major components in all types of electrical filtering devices.

Transformers

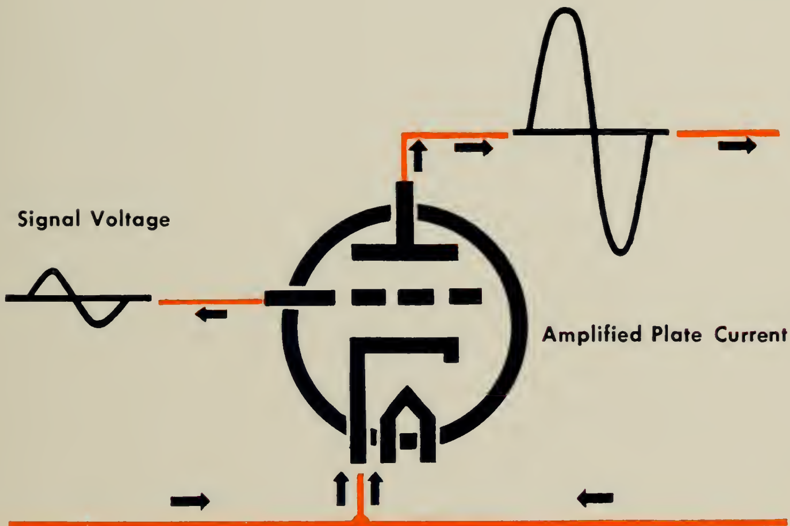
Transformers consist of two or more closely associated inductive reactors. The magnetic fields produced by one thus react on the others, and vice versa. They do not necessarily have to be separate coils, for as has been explained, the field produced by a unit section in a coil reacts on all the other sections of the coil. Thus, in one sense, even a single winding is a transformer, and indeed one very large class of transformers, the "auto-transformers" have only one winding; the impedance matching transformers in some of the larger Motiograph-Mirrophonic loudspeaker systems are of this type. The transformers with which we are concerned in amplifiers, however, usually have at least two separate windings or coils, coupled only by being close to each other, and by being wound on a common magnetic core material. In such transformers direct currents cannot pass from one winding to another, and they are thus useful where it is desired to pass on alternating current energy to other circuits without also providing a path for direct currents.

One of the most important uses for transformers is that of transferring alter-



The tube as a rectifier—the anode is positive and attracts electrons, then negative, then positive again

nating current energy from one circuit to another at a different potential or voltage. The ability to do this comes about from the fact that virtually all of the electrical energy applied to the "in," or "primary" winding of the transformer is converted by the action of this winding into a fluctuating magnetic field. This field then induces a voltage in the "out" or "secondary" winding, and the secondary becomes capable of delivering power to a connected load impedance. The secondary voltage is equal to the primary voltage only if the two windings have the same number of turns, however, and if they do not, the secondary voltage differs from the primary voltage in direct proportion to the ratio of the turns in the windings. The total power in the secondary circuit does not differ from that in the primary, except for being slightly less due to small heat losses in the transformer windings and core, for the secondary current is in inverse proportion to the change in voltage. This voltage changing ability makes the transformer an indispensable part of electrical systems for the transmission of power over considerable distances, for a given amount of power can be transmitted at high voltage and low current with relatively low losses in the conductors because the conductor loss is proportional only to the current value and to the resistance of the conductor.



The process of amplification, showing how the plate current wave takes exactly the same shape as the signal voltage

Transformers are used in amplifiers to change the power line voltage to the higher and lower values needed for the various circuits, and as coupling devices in the actual sound circuits. It is a well established rule in electrical circuits that energy is transferred from one circuit to another with minimum loss when the circuits have matched impedances. With transformer coupling, this desirable condition can be easily established, for a given impedance connected to one winding appears, when viewed from another winding, to be multiplied by a quantity, the impedance ratio, which depends upon the ratio of the num-

ber of turns in the two windings. This follows from the statement in the preceding paragraph that except for small losses, the power in the windings is the same, although the ratio of voltage to current may be very different. The impedance ratio is actually equal to the square of the turns ratio.

Low impedance circuits are somewhat less subject to noise pickup than those of high impedance. Photocell circuits are of very high impedance, and are followed by a great deal of amplification. In many older style sound systems they are coupled to the amplifiers via transformers, one in the sound reproducer to give a low impedance output circuit, and another at the amplifier to approximately match the high grid circuit input impedance. Such transformers are difficult and expensive to manufacture, however, and are not too reliable in operation, since they must contain windings of many turns of very fine wire, and must be very thoroughly shielded to prevent hum and noise pickup. In the more modern systems the photocell circuits are directly coupled to the amplifiers via low-capacity coaxial cables, resulting in almost perfect shielding and the elimination of at least two sources of possible breakdown.

Theatre Amplifiers

II. Amplifier Design

By R. T. VAN NIMAN

To deliver the fairly large amounts of acoustical energy needed to produce adequate sound loudness in auditoriums for the presentation of sound motion pictures, loudspeakers must be provided with considerable electrical driving power by the final amplifier stage. According to present industry standards, a 750 to 800 seat theatre needs about 15 watts of amplifier output power. While this amount is not large in comparison with the powers needed for the operation of many common electrical devices, it still calls for the use of relatively large vacuum tubes in the final amplifier stage, since all of this power must come from the final stage. The preceding stages function only to increase the magnitude of the low signal voltage produced by the sound reproducer to the degree necessary for control of the action in the final stage. The final stage is usually referred to as the "power" or "output" stage of the complete amplifier, and it may consist of a single tube, or of two or more tubes operating in parallel so as to be able to deliver more power than can be handled by a single tube.

The alternating component of the total plate circuit current in the output stage is the useful signal energy which must be transferred to the loudspeaker system. Vac-

uum tube plate circuits are inherently fairly high in impedance; loudspeakers are inherently low in impedance because of space and weight limitations in the design of their voice coils and cones or diaphragms. If loudspeakers were to be directly connected into the plate circuit, there would be lost, due to impedance mismatch, much of the signal energy. The most commonly used method of surmounting this difficulty is to interpose a transformer between the plate circuit and the loudspeaker system. As was explained in Section I, the transformer performs the impedance matching function and at the same time separates the steady direct current component of the plate current from the wanted signal currents.

A widely used and exceedingly useful variation on the parallel operation of tubes consists of the circuit arrangement usually referred to as a "push-pull" circuit. In this arrangement the signal voltage for driving the output stage is divided into two parts by means of auxiliary apparatus, and these are then applied individually to the tubes comprising the output stage. The resulting signal powers in the plate circuits of the output tubes are then combined in the proper relationship by means of a transformer having a two-section primary, and the combined signal power is then delivered to the loudspeaker load from the secondary winding of this transformer.

Inherent in the combining process is a marked cancellation of the distortion, or failure of the output signal currents to be exact copies, as far as their rates and manner of variation are concerned, of the incoming signal voltages because of imperfections in the operation of the vacuum tubes. For a given amount of tolerable distortion, therefore, it is thus possible to obtain more power from a pair of tubes of specific size when they are operated push-pull than can be obtained if they are simply connected in parallel. For still more power without going to much larger tubes, two or more tubes of the same type are frequently connected in parallel on each side of the "push-pull" circuit.

Amplifier Gain Stages

As contrasted with the output or power stage, all of the other stages in theatre amplifiers (except for a few special-purpose types to be discussed later) are "voltage amplifier" or "gain" stages, since their function is to produce an increase, or "gain" in the magnitude of the signal voltage. They usually consist of single, and fairly small vacuum tubes, since we are concerned now, not with the handling of power, but with the development of relatively large AC voltages in the tube's plate circuit from relatively small AC voltages applied to its grid circuit. The tube action in doing this was explained in Section I, and as was mentioned at that time, the AC component of the tube's plate current can be used to develop a corresponding AC signal voltage, which in turn can be used to control the action in following stages. Suitable transformers can be used for this coupling function, or the plate circuit may be arranged so that the fluctuating plate current flows through a high resistance or an inductive reactor and thus produces across the terminals of the resistance or reactor the needed AC signal voltage, which is then passed on to the following stage via a condenser. The condenser prevents any flow of DC from the plate circuit of the first tube into the grid circuit of the following tube, but does not greatly hinder the passing on of the AC signal voltage.

The signal voltage developed in the photo cell circuit of the sound reproducer is so low in magnitude that amplifiers for use in motion picture sound systems usually contain at least two and frequently as many as four to six gain stages ahead of the output, or power stage. The amplification, or gain per stage, depends upon the type of tube used, upon the circuit arrangement and value of components, and upon many other factors. Gain is frequently deliber-

ately sacrificed in the design of amplifiers in order to secure some more desirable quality, such as reduced over-all distortion, or a needed variation in the response of the amplifier to input signal voltages of differing frequencies or an improvement in the ratio of the output signal current to that representing noise or hum originating within the amplifier circuits. All of these qualities are of great importance in amplifiers intended for use in theatre sound systems capable of giving truly life-like sound reproduction.

Amplifier Power Supply Circuits

Vacuum tubes used as amplifiers must have a source of electrical energy to heat their cathodes or filaments to operating temperature and a source of DC energy to establish the correct operating potentials for the various tube elements. Photocells in the sound reproducer also need a DC polarizing potential.

The electron emission from a tube cathode or filament is dependent upon the temperature of the structure. If alternating current is used to produce the heat, there will be small variations in the electron emission corresponding to the current alternations, and these variations will appear as hum of twice the power line frequency in the output signal from the tube. In the early days of radio, and even in the early sound motion picture equipment, this difficulty was obviated by heating the tubes with direct current from storage batteries. In later days batteries were replaced by motor-generators or rectifier-type power units with heavily filtered output circuits to provide the direct current.

As time went on, tube manufacturers produced cathode and heater designs which so greatly reduce the modulation of the electron stream by heater current variations that alternating current can be used for this purpose even in amplifier stages which are followed by considerable amplification. All modern theatre amplifiers use AC-operated tubes throughout, though, as was brought out in the article on sound reproducers for best quality sound reproduction from film, it is still necessary to heat reproducer exciter lamps with direct current.

The operating voltages of heaters and filaments in tubes currently used in theatre amplifiers are much lower than power line voltages. These relatively low voltages are obtained from step-down transformers incorporated in the amplifier assembly, and such transformers may have several secondary windings to provide different voltages for the various types of tubes in the complete amplifier.

As in the case of tube filaments and heaters, the DC potentials required for operation of the other tube elements and for operation of photocell circuits were obtained from batteries in the early days. With improvements in rectifier and filter designs it eventually became possible to supply these circuits with rectified and filtered energy from the power lines, and all modern theatre amplifiers are completely AC operated.

The power requirements are relatively small, so it is usually possible to build the rectifier and filter circuits directly into the amplifier assembly. The potentials required are ordinarily considerably above the power line voltage, so the first component of the rectifier is a step-up transformer. Its secondary voltage is chosen somewhat higher than the maximum DC potential needed in the amplifier circuits so as to compensate for losses in the rectifier element proper.

The rectifier in amplifiers is almost always of the two element tube type discussed in Section I of this article, and in fairly low-power amplifiers it is customary to use the full-wave type having two sets of elements in one bulb because of the more easily filtered output current. For high voltage rectifiers in heavy-duty power amplifier stages, separate half-wave rectifier tubes are used in the full-wave circuit because of insulation difficulties in the fullwave tubes.

The pulsating but uni-directional output current of the rectifier tube, or tubes, goes

to the amplifier filter circuits. These are networks of inductors, capacitors and resistances, and they smooth out the pulsations by virtue of their properties discussed in Section I so that the resulting output energy is virtually free from AC components. The resistive elements also act as voltage dividers to provide just the correct potentials for the various tube circuits in the amplifier and for operation of the external photocell circuits.

Preamplifier or voltage amplifier

Power Ratios and Decibels

Before going on to consideration of an actual amplifier design, some comments on the methods of rating and referring to such amplifier characteristics as gain, noise level, power output and distortion are in order. It is entirely possible to discuss these characteristics in terms of the fundamental electrical units and obvious ratios. For example, gain could be rated as the number of times the output signal exceeded the input signal in power, and the amount of unwanted noise and distortion originating in the amplifier circuits could be given in electrical watts. Actually, only the power output of an amplifier is customarily given in watts. Distortion is frequently given in percent of the maximum output power, but this characteristic and gain and noise level are more conveniently expressed in terms

of decibels, the familiar "db's" of the sound engineers.

There is nothing particularly mysterious about the decibel. Very early in the study of sound and hearing it was discovered that the ear is a far from linear apparatus; that is, a sound of twice the actual power of another similar sound does not appear to be twice as loud, but only just perceptibly louder. This, in part, accounts for the literally enormous range of sound intensities we can hear; over much of this range the relationship between the loudness and the power ratio is logarithmic in nature, that is, the loudness varies more or less in proportion to the logarithm of the power ratio.

Engineers concerned with the transmission, recording and reproducing of speech and music arbitrarily and for convenience in calculations adopted the logarithm of the power ratio, multiplied by ten to avoid excessive decimals, as a device for expressing the power ratios. In this manner, the extremely large ratios encountered can be expressed in numbers of few digits, and the gains or losses produced by various sections of apparatus in a complex circuit can be combined by simple algebraic addition and subtraction, instead of by means of cumbersome multiplication or division of large numbers.

The logarithm of 1 is zero; where two power levels are equal, and their ratio is hence 1, the gain or loss in decibels is therefore zero. The logarithm of 100 is 2; where one power level is 100 times another or one one-hundredth of another, it can be said that they differ by 20 db. Referred to an item of apparatus, in the case where the output power was 100 times the input power, the apparatus would have a gain of 20 db. If the output power was one one-hundredth of the input power, as it might be in certain types of filter and equalizing networks, the apparatus has a loss of 20 db. In combining gains and loss, gains are considered positive in sign and losses are negative in sign.

It may seem that it is not much easier to write "20" than "100," and this is true. Where the decibel really comes in handy is in the large power ratios. For example, the gain in most theatre amplifiers is around 100 db. It is a great deal simpler, if not quite as impressive, to write this than the corresponding power ratio of 10,000,000,000!

The concept of "power level" derives from the fact that ratios can be whole numbers indicating gains, with corresponding positive decibel equivalents, or fractional numbers indicating losses, with corresponding negative decibel equivalents. This gives a power level scale something on the order of the temperature scales with which we are all familiar. By assigning some actual power in watts to the zero point of this scale, we thus have a very convenient way of referring to very large or very small powers. This procedure is particularly useful in dealing with communication equipment, where power levels are often extremely low, so that calculations in watts would involve formidable decimals.

Various zero reference values are currently in use in different parts of the communication industry; six milliwatts (.006 watts) is customary in the motion picture sound equipment field. One milliwatt (.001 watt), with the resulting integral steps called "volume-units," or "vu's," is used in some of the newer equipment designed to indicate power levels, particularly in radio broadcasting apparatus.

Amplifier Gain and Power Output

It should be evident that "gain" is simply the ratio between the input power and the output power, in other words, a measure of the number of times the power is amplified. It is not any particular value of power in watts any more than is, say, an amplification of 100,000 times, or 50 db. This point is elaborated upon to combat the frequent confusion that exists regarding gain and output power. A high-gain amplifier is not necessarily one capable of delivering considerable output power, and

conversely, very high-powered single stage power amplifiers frequently have little gain measured in decibels. The confusion probably arises from the common practice of rating amplifier output powers in decibels relative to the six multi-watt zero reference sound reproducer is very low. Theatre amplifiers must therefore have a relatively large amount of gain, in the order of 100 db, as has been mentioned. Not all of this gain is normally used, of course, since it is considered good practice to have at

Motiograph-Mirrophonic MA-7505-A Amplifier

level. An amplifier with an output of 34 db/.006 watts thus may have a quite different total gain rating. The "34 db/.006" means merely that the rated output power is 34 db greater than the zero reference power of six milliwatts, or about 15 watts.

The power level at the output of the

least 20 db spare gain available to take care of films with abnormally low levels of sound track modulation and to allow for variations in the sensitivity of photocells, variations in vacuum tube characteristics, etc.

The value of amplifier output power in

watts needed for various sizes of theatres has been established by observation and experience. A chart showing the recommendations of the Research Council of the Academy of Motion Picture Arts and Sciences will be found published. As is noted on this chart, the ratings are on the basis of two percent total distortion in the amplifier system.

Distortion and Noise Level

All amplifiers produce some distortion of the signal voltages applied to their inputs. By elaborate design precautions it is possible to reduce this distortion to very low values if there are no cost limits and if the application warrants it. The term "distortion" is applied to the products of various things that take place within the amplifier which result in the output signal being an unfaithful copy of the input signal. It can be shown mathematically that the distortion is the result of the generation within the amplifier of signal components which were not present in the input signal, and it is possible to accurately measure these components, or distortion products, with suitable instruments.

The distortion is usually given in per cent. For example, an amplifier having a rating of 15 watts at two percent distortion will deliver 15 watts of output signal, and this output signal will not have over two percent total distortion components. Another method of rating is to specify in decibels the ratio between the full output power and the power represented by the distortion products. By this method, distortion would be said to be so many "db down" from the rated power output.

At the present time it is customary to measure distortion in amplifiers by applying a single frequency signal to the input and then, at the output, this frequency is eliminated with special filters, leaving only the distortion products, which can thus be measured separately. It is probable that in the years to come this method will be superseded, for motion picture equipment amplifiers at least, by a more complicated method which takes into account the fact that the various frequency components of a complex input signal interact upon each other resulting in sum and difference components in the output signal which may not be in harmonious relationship to the original frequency distribution. This sort of distortion is called "intermodulation" or "cross-modulation." The studios have been using intermodulation measurements for years as a check on their recording, developing and printing processes, but the use of such measurements in rating reproducing equipment is fairly new. The advantage lies in the fact that the results of such measurements are apparently a much better indication of what the listener considers to be objectionable distortion than are the results of single frequency distortion measurements.

The causes for distortion in amplifiers are numerous. The tube action in producing an enlarged copy of the input signal in the tube plate circuit is not quite perfect, and may be very imperfect if the associated circuits are not just right. Poorly designed transformers may cause considerable distortion, and many other components, as well as the overall circuit design may radically affect the amount of distortion present in the output signal from the complete amplifier.

Noise originating within the amplifier circuits is usually considered apart from distortion of the signal, although in one sense it is likewise distortion, for it represents a component of the output not present at the input. In high-gain, multi-stage amplifiers, the limiting factor on the amount of gain which can be usefully employed is the random noise originating in the input circuits due to thermal agitation within the conductors making up the circuits, and to somewhat similar effects within the vacuum tubes. This sort of noise is not particularly troublesome in theatre amplifiers, for the signal level from the sound reproducer, while quite low, is

yet far above such noise levels. More important in such applications is noise due to inadequate filtering of power supply circuits, and miscellaneous hum and spark click pickups caused by poorly shielded input circuits. In theatre projection rooms filled with other electrical equipment there are always strong stray magnetic electrostatic fields to introduce objectionable noise into amplifier sound circuits unless great care is taken to insure that they are well-shielded against such disturbances.

Noise levels in theatre amplifiers are usually stated in terms of the zero db reference level, since the noise ordinarily is independent of the amount of signal going through the amplifier. Since much of it originates in the input stages, it is necessary to specify at what gain control setting the noise is measured where the gain control follows an input stage, as it usually does. As an example, the Motiograph-Mirrophonic PA and MA-7505-A Amplifiers have a noise level of—35 db with respect to the six milliwatt zero reference level (—35 db/.006 W.) at average operating gain, or step 10 on the 20 point gain control. With the input stage out of the circuit the noise level drops 10 db to —45 db/.006 W. In terms of the maximum output power level of 20 watts, or 35.2 db/.006 W. the noise level at operating gain is thus 70.2 db below the maximum signal level, an amount which insures that all of the noise which can be heard in the reproduced signal is due to that originating in the sound reproducer or to noise recorded directly in the sound track.

Reducing Noise and Distortion

The usefulness of thorough and complete shielding of amplifier input circuits

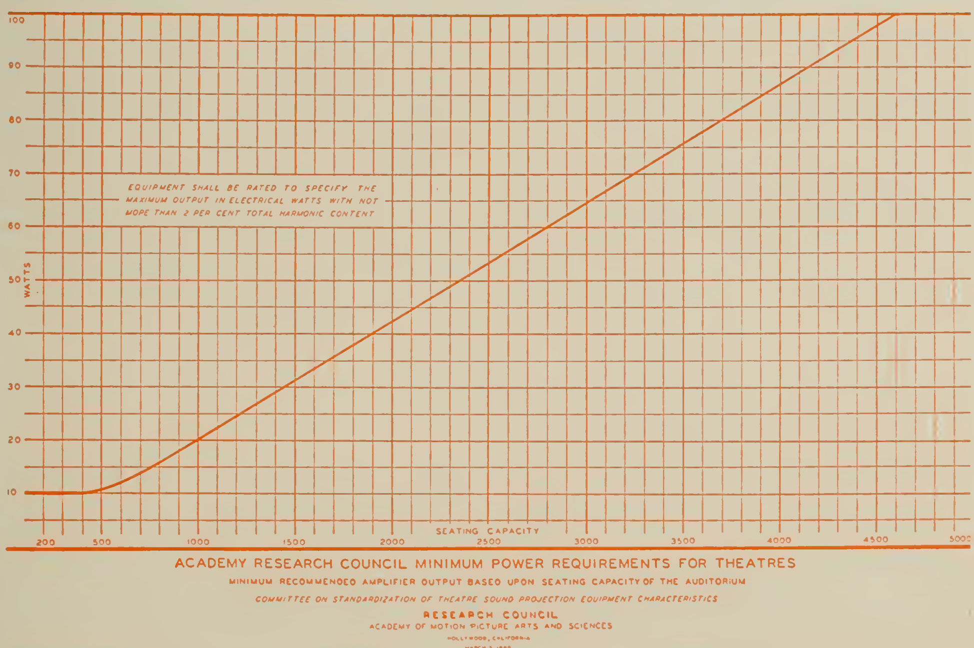


Chart of the Academy Research Council, showing minimum power requirements for theatres

in reducing noise pickup has already been cited, and reference has been made to modern tube designs which permit the use of alternating current for tube heater and filament operation without the introduction of excessive hum into the amplifier circuits. The push-pull operation of tubes in the final amplifier stage helps to reduce both the noise level and the distortion.

Perhaps the most significant development in amplifier design of the past few years is the use of inverse feedback, or degeneration. In any device in which amplification or gain takes place, if arrangements are made so that the device supplies its own input energy we have an oscillator, or generator of oscillating energy. In the amplifiers which we are discussing in this article, this would mean that there would have to be sufficient coupling of one kind or another between the input and output circuits so that the input signal could be supplied from the energy in the output circuit. If the coupled energy is in phase, that is, if the alternations are in step, the action tends to increase the signal and sustained oscillations may result. The process is called regeneration. Accidental regeneration is of course undesirable in theatre amplifiers, and it is avoided by shielding and separation of input and output circuits, and by heavy filtering in the common power supply circuits to the various amplifier stages.

If the coupled energy is *not* in phase, that is, is not in step with the original input signal, a loss of gain, or degeneration, takes place. At first glance this seems just about as undesirable as having the amplifier turn into an oscillator from regeneration. It turns out, though, that several very important advantages appear to offset the loss in gain. Noise originating within the feedback loop is partially cancelled out by the degenerative action, and so is distortion. The amplifier operation becomes greatly more stable, and is less affected by such things as the unavoidable variation of loudspeaker load impedances with frequency.

It is relatively easy and not very expensive to provide in the amplifier design sufficient extra gain so that what remains after the introduction of inverse, or negative feedback will be adequate for the purpose the amplifier is to serve. Virtually all theatre amplifiers of modern design are of the inverse feedback type, and a great deal of their excellent performance and high efficiency is due to the use of circuits incorporating the inverse feedback principle.

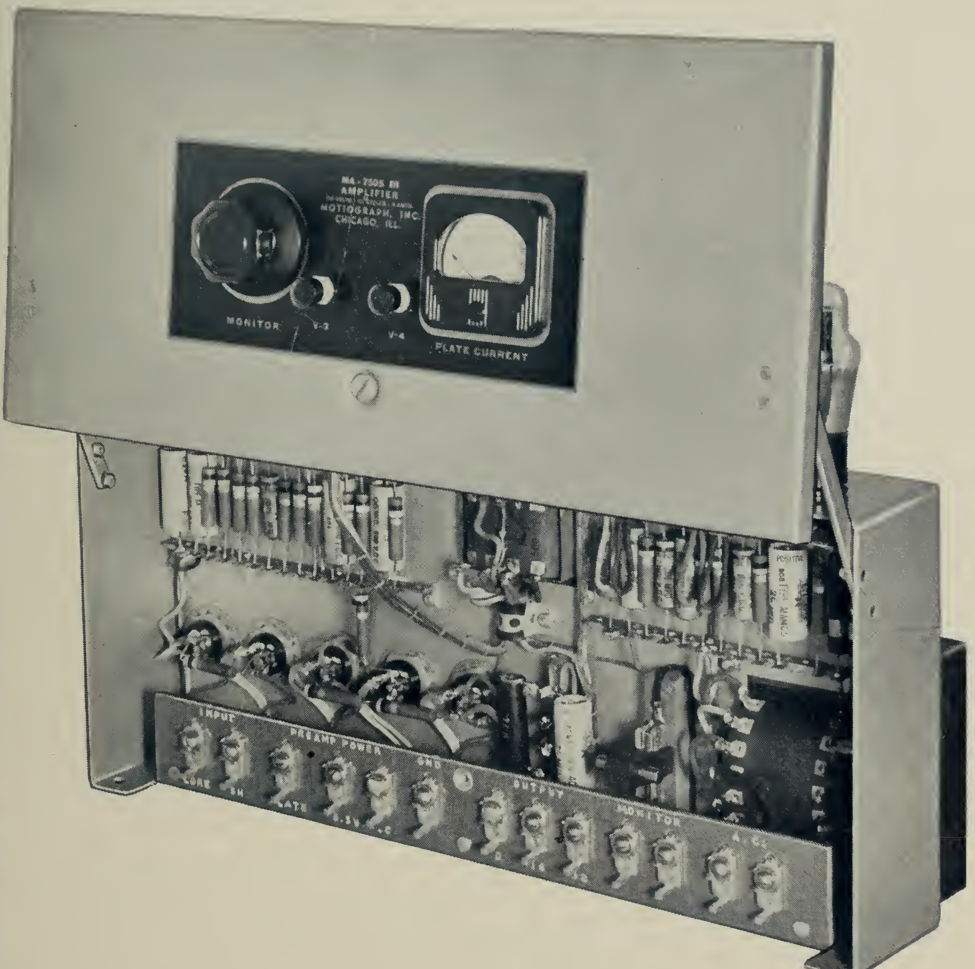
7505-A Type Amplifiers

The photographs and schematic wiring diagrams which illustrate this section of the present article on theatre amplifiers show the Motiograph-Mirrophonic PA and MA-7505-A Amplifiers which are used in the M-9-B, M-911 and M-911 Dual Sound Systems. The amplifiers are specifically designed for service in motion picture sound reproducing systems, and have many design features which contribute heavily to their exceptional suitability for this type of service. The M-9-B and M-911 systems employ one PA-7505-A and one MA-7505-A Amplifier, giving these systems a rated amplifier output of 20 watts. The M-911-Dual system has an additional MA-7505-A Amplifier and both such amplifiers are mounted on a standard relay rack type supporting frame along with a switching panel which permits either amplifier to be used separately in the event of some emergency making the other inoperative, or to be operated in parallel giving this system a rated output of 40 watts.

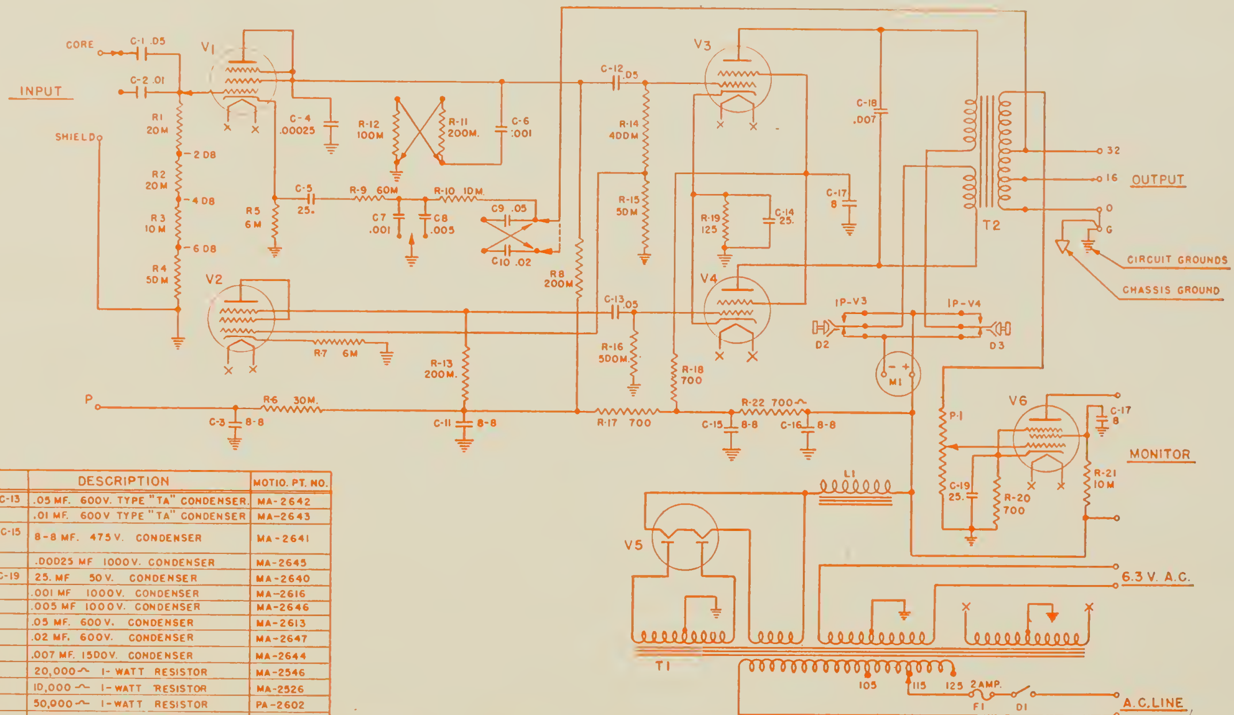
Next to good quality performance, there is probably no requirement of theatre amplifiers more severe than that of reliability. In all theatre equipment, continuity of operation is extremely important. Large financial losses may be incurred very quickly if some piece of equipment fails to work when the house is full of people, and this is especially true of amplifiers. Low-cost designs of the type used in much public address equipment, and construction methods derived from the manufac-

ture of cheap radio receivers, are not conducive toward reliable operation. The relatively small additional first cost of sound systems having amplifiers with high-grade components, liberal design safety factors, and rugged construction methods is an investment of the soundest kind for the theatre owner.

These considerations have been applied in the design and manufacture of the 7505-A type amplifiers. Components such as resistors, condensers, transformers, etc., are used well under the manufacturer's ratings, and there are many points in the mechanical and electrical design which insure reliable operation and simple main-



Motiograph-Mirrophonic MA-7505-A Amplifier with chassis cover raised



DESIG.	DESCRIPTION	MOTIO. PT. NO.
C-1, C-12, C-13	.05 MF. 600V. TYPE "TA" CONDENSER.	MA-2642
C-2	.01 MF. 600V TYPE "TA" CONDENSER	MA-2643
C-3, C-11, C-15 C-16, C-17	8-8 MF. 475 V. CONDENSER	MA-2641
C-4	.00025 MF 1000V. CONDENSER	MA-2645
C-5, C-14, C-19	25. MF 50 V. CONDENSER	MA-2640
C-6, C-7	.001 MF 1000V. CONDENSER	MA-2616
C-8	.005 MF 1000V. CONDENSER	MA-2646
C-9	.05 MF. 600 V. CONDENSER	MA-2613
C-10	.02 MF. 600V. CONDENSER	MA-2647
C-18	.007 MF. 1500V. CONDENSER	MA-2644
R-1, R-2	20,000 ∼ 1-WATT RESISTOR	MA-2546
R-3, R-10	10,000 ∼ 1-WATT RESISTOR	MA-2526
R-4, R-15	50,000 ∼ 1-WATT RESISTOR	PA-2602
R-5, R-7	6,000 ∼ 1-WATT RESISTOR	MA-2655
R-6	30,000 ∼ 1-WATT RESISTOR	PA-2605
R-8, R-11, R-13	200,000 ∼ 1-WATT RESISTOR	MA-2657
R-9	60,000 ∼ 1-WATT RESISTOR	MA-2656
R-12	100,000 ∼ 1-WATT RESISTOR	MA-2542
R-14	400,000 ∼ 1-WATT RESISTOR	MA-2656
R-16	500,000 ∼ 1-WATT RESISTOR	MA-2659
R-17, R-18, R-22	700 ∼ 1-WATT RESISTOR	MA-2654
R-19	125 ∼ 20-WATT RESISTOR	MA-2651
R-20	700 ∼ 10-WATT RESISTOR	MA-2652
R-21	10,000 ∼ 10-WATT RESISTOR	MA-2653
D-1	S.P.S.T. TOGGLE SWITCH	MA-2521
D-2, D-3	PUSH BUTTON SWITCH	MA-2605

DESIG.	DESCRIPTION	MOTIO. PT. NO.
P1	POTENTIOMETER 200,000 ∼	MA-2525
M1	METER 0-200 MA	MA-2636
T1	POWER TRANSFORMER T-47868	MA-2637
T2	OUTPUT TRANSFORMER T-47870	MA-2638
L1	CHOKE COIL T-47869	MA-2639
V1, V2	6SJ7 VAC. TUBE	
V3, V4	6L6G VAC. TUBE	
V5	5Z3 VAC. TUBE	
V6	6K6 VAC. TUBE	
F1	FUSE 2-AMP.	MA-2681

NOTES

1. WIRES ENDING THUS ⟶ ARE TO BE CONNECTED IN FIELD AS REQUIRED. SEE INSTALLATION INSTRUCTIONS

Schematic diagram of Motiograph-Mirrophonic MA-7505-A Amplifier

tenance. Some of these will be brought to attention in the detailed description of the amplifiers which concludes this article.

The noise level of the PA and MA-7505-A amplifier combination has already been given in the discussion of amplifier noise levels in general. The power output ratings of 20 watts for a single MA-7505-A Amplifier, and 40 watts for two operating in parallel are on the basis of single frequency distortion measurements in the frequency range from 50 to 5000 cycles, and with a distortion limit of two percent of the rated output power. This method of rating is that recommended at present by the Research Council of the Academy of Motion Picture Arts and Sciences. The total gain of the amplifier combination is 98 db.

Mechanical Design of PA-7505-A Amplifier

The chassis of the PA-7505-A Amplifier is somewhat unconventional in design. The usual "bottom" of the chassis faces outward when the amplifier is mounted in its associated cabinet, thus making all components exceptionally accessible for inspection and servicing. Tubes and input stage balancing controls occupy the upper side of the chassis, and the lower side, upon which the chassis rests in the cabinet, is provided with insulated openings for entrance of the external connection wires and cables. Coaxial cables carrying the output signals from the sound reproducers connect directly to terminals on the lower internal main terminal strip, thus insuring virtually perfect shielding of these very sensitive circuits. Additional shielding is provided by the perforated metal chassis cover which also protects the operator from accidental contact with the high voltage amplifier circuits.

The main volume control and the changeover switch are mounted on an upright bracket at one corner of the chassis with their shafts horizontal so that they may be turned from either projector operating position by means of extension control shafts. These shafts, with part of their associated knobs and dials, may be seen in the photograph showing the amplifier assembled in its cabinet. Both controls are of the high reliable commutator type noted for positive contact and smooth functioning. Resistors in the volume control are standard insulated types, not fragile bundles of resistance wire, and connections to the moving contact arms are made by clock-spring type pigtails. Contact arm fingers, and the commutator segments, are made of beryllium copper, one of the best materials yet found for this service.

The molded bakelite tube sockets are supported by gum rubber bushings; these, in conjunction with the extra-flexible wires to the socket contacts, provide the vibration insulation which is essential in preventing the pickup of mechanical noise by the amplifier input stage tubes acting as microphones. Most of the smaller resistors and condensers are supported by two long, multi-position terminal strips in a single row. This results in a simple and uncrowded assembly, and makes for very short and direct connection leads to the various components.

PA-7505-A Amplifier Circuit Design

From the schematic wiring diagram of the PA-7505-A Amplifier it will be evident that electrically the unit consists of individual input stages for each of two sound reproducers, and a common output stage working from the input stages through the changeover switch and main volume control potentiometer. Alternating current for the tube heaters and direct current for the various plate, screen and photocell polarizing voltage circuits are obtained from the associated MA-7505-A Amplifier. This procedure allows the PA-7505-A Amplifier to be relatively small and compact, so that it occupies but little projection room front wall space between the projectors, and also

insures that the sensitive input circuits will be free from noise and hum pickup from too closely associated power supply components.

All three vacuum tubes are type 6SJ7, and the two tubes comprising the input and phase inverter stages of the MA-7505-A Amplifier are likewise type 6SJ7. The 6SJ7 tube is a standard type made by many different tube manufacturers, and it is relatively non-microphonic and very stable in characteristics. With so many tubes of the same type in use in the amplifier system it is thus possible to select for use in the input stages the quietest ones, thus materially aiding in keeping the system noise level at a low value. The 6SJ7 is a single-ended tube, that is, all connections to its elements come out through the base. This considerably simplifies amplifier wiring and eliminates the need for long shielded grid leads which sometimes pick up disturbances in spite of the shielding, and occasionally short circuit, causing loss of sound.

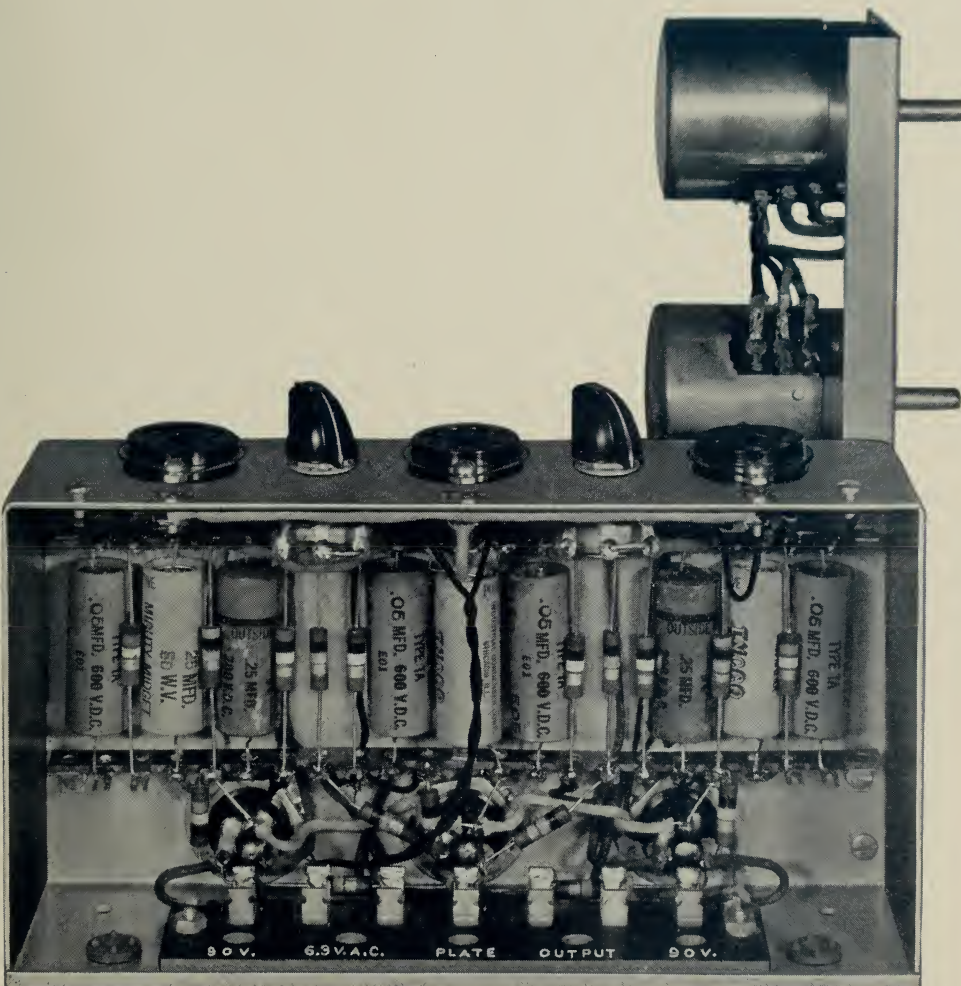
The steady grid bias voltages which establish the proper operating conditions within the tubes are obtained from the voltage drop across resistors connected between the tube cathodes and the negative side of the power supply circuit, which is at ground potential. The voltage drop results from the flow of the tube plate and screen currents through the resistor, and this causes the cathode to be positive with respect to ground. Since the grid is at ground potential, as far as DC is concerned, this amounts to the same thing as applying a negative potential between cathode and grid, and this is what is needed for tubes functioning as amplifiers. Plate and screen potentials reach tubes via rather heavy resistance-capacity filter circuits to prevent regeneration in the common power supply. Additional resistance-capacity filter circuits provide the virtually perfect direct current needed for operation of the sound reproducer photocell circuits, and lower the main power supply potential from the 200 volts received from the MA-7505-A Amplifier to the approximately 90 volts required by the photocells.

Referring again to the schematic diagram, and confining the discussion to one or the other of the input stages since both function in the same manner, the weak signal voltages from the sound reproducer are applied to the input tube grid through a small coupling condenser. The condenser passes the alternating signal voltage, but prevents the steady bias potential on the grid from reaching the reproducer circuit, and likewise prevents the steady potential in this circuit from affecting the grid circuit. The input stages are pentode-connected, that is, have the tube screen grid maintained at a steady potential by a separate connection to the power supply circuits, in order to take advantage of the greater amplification afforded by this type of operation.

The amplified signal voltage from the tube plate circuit reaches the grid of the output tube through the changeover switch and main volume control potentiometer. Again coupling condensers serve to prevent the steady plate potentials of the input stages from affecting the bias voltage of the output stage. Condensers for this purpose must have very high leakage resistance, since even extremely minute leakage currents may radically affect the operation of the following stage. Throughout the 7505-A type amplifiers, coupling condensers are of a type specially developed for war communication equipment. They are conventional in appearance, but the wax paper separating the foil electrodes is extra high grade, and the containers are hermetically sealed against the entrance of moisture, the usual cause for excessive leakage. The test insulation resistance runs well over 1500 million ohms, a value entirely adequate to prevent trouble of the type cited.

Very useful features of the PA-7505-A Amplifier are the balancing controls just ahead of the changeover switch. These permit the effective gain of the input stages

to be individually and continuously varied over a range of approximately 8 db to compensate for variations in reproducer exciter lamp and photocell efficiencies. The reproducer outputs can thus be exactly balanced so that no main volume control setting changes need be made at changeover between feature picture reels. The controls are potentiometers used as variable resistors, and the circuit arrangement is such that in the rare event of contact failure within the potentiometers, the gain comes to maximum, with no change for opening of the main signal voltage circuit.



Motiograph-Mirrophonic PA-7505-A Amplifier with chassis cover removed

The output stage is triode-connected, that is, all the tube control elements except

the control grid closest to the cathode, are connected together to function as the plate in elementary triodes. The stage gain is less than that obtainable from the pentode connection, but is still adequate for the purpose, and operation is more stable because of the lowered plate circuit impedance. The plate circuit in fact can be extended a considerable distance by means of low-capacity coaxial cable to the associated MA-7505-A Amplifier(s) without the need for coupling transformers of any kind. This coupling system is the same as that employed between the sound reproducers and the input stages, and it is so simple and direct, having no intricate components to break down or pick up disturbances, that the overall reliability of the amplifier system is very markedly improved.

Mechanical Design of MA-7505-A Amplifier

In the same manner as the PA-7505-A Amplifier chassis, the chassis of the MA-7505-A Amplifier rests on one side in its associated cabinet with the conventional "bottom" facing outward. Tube sockets occupy the upper side, and larger components such as the power transformer, the power supply filter circuit choke coil, and the main filter condensers are mounted on the chassis surface which would ordinarily be its "top," but which in this method of use becomes the rear surface. All component terminals are inside the chassis; the heaviest items—the power transformer and the choke coil—are mounted near the bottom to give mechanical stability to the assembly, and the filter condensers are likewise near the bottom and to the left side well away from heat radiation which might shorten their lives. Most of the smaller components are mounted on long, multiposition terminal strips so that many connections are made by straps and short, direct leads. Longer circuit leads are cabled together to give a neat appearance to the interior wiring. All wiring is color coded to facilitate circuit checking and maintenance.

Connections to the amplifier are made at the large main terminal board inside the lower edge of the chassis. In operation the terminals are covered by the metal panel which closes the chassis and supports the monitor volume control and the metering facilities. This panel is provided with hinge arms of novel design which permit it to be swung upward and outward to a rest position which completely exposes the interior of the chassis and all connections. The usefulness of this feature in testing and maintenance is almost self-evident. The panel is held in its closed position by studs and a locking screw, the latter to comply with insurance underwriter requirements.

Electrical Design of the MA-7505-A Amplifier

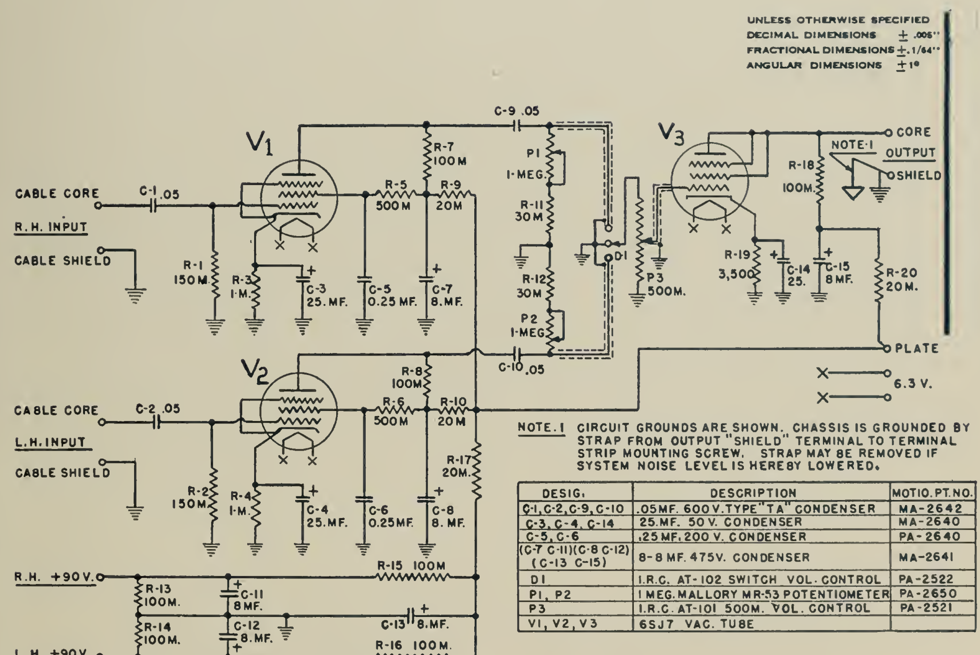
Analysis of the schematic wiring diagram of the MA-7505-A Amplifier will show that it consists of two stages for the main sound circuit, and an auxiliary single stage monitor amplifier driven from the push-pull output stage. Except for the push-pull output transformer, all coupling is by means of resistance-capacity networks, and the inverted phase signal voltage required at the grid of the second push-pull output tube is obtained from a triode-connected 6SJ7 tube functioning as a phase inverter stage. The phase must be inverted, or "out of step" with the grid voltage of the first tube so that the signal currents from the two tubes will properly combine in the output transformer.

The signal voltage appearing in the plate circuit of any tube functioning as an amplifier is reversed in phase with respect to the signal voltage in the grid circuit because it is produced by the varying plate current flowing through some kind of a coupling impedance, for example, a resistor. As the current increases in response to the upswing of grid voltage, the voltage between plate and tube cathode falls due to the increasing voltage drop in the re-

sistor; when the grid voltage swings negative, with a corresponding decrease in plate current, the plate voltage rises because of the decreased voltage drop. This action accounts for the phase reversal.

The input tube in the MA-7505-A Amplifier amplifies the signal applied to its grid, and the larger signal voltage appearing in its plate circuit is applied to the grid of the first push-pull output tube via the usual coupling condenser. Part of this voltage is tapped off the grid resistance of this tube and applied to the grid of the phase inverter tube, the amount being just sufficient so that the amplified signal in the plate circuit of the latter tube will be equal in magnitude, though opposite in phase, to that from the input tube. This reversed-phase signal is then fed to the grid of the second push-pull output tube via a coupling condenser.

There are other methods of obtaining the out-of-phase signal voltages required for push-pull amplifier stages, for example, using a coupling transformer with a center-tapped secondary winding. Such transformers must be very well designed, however, and must be thoroughly shielded to prevent difficulties from hum and noise pickup from stray magnetic fields. By con-



DESIG.	DESCRIPTION	MOTIO. PT. NO.
C-1, C-2, C-9, C-10	.05MF. 600V. TYPE "TA" CONDENSER	MA-2642
C-3, C-4, C-14	25.MF. 50 V. CONDENSER	MA-2640
C-5, C-6	.25 MF. 200 V. CONDENSER	PA-2640
(C-7 C-11)(C-8 C-12) (C-13 C-15)	8-8 MF. 475V. CONDENSER	MA-2641
D1	I.R.C. AT-102 SWITCH VOL. CONTROL	PA-2522
P1, P2	1 MEG. MALLORY MR-53 POTENTIOMETER	PA-2650
P3	I.R.C. AT-101 500M. VOL. CONTROL	PA-2521
V1, V2, V3	6SJ7 VAC. TUBE	

DESIG.	DESCRIPTION	MOTIO. PT. NO.
R-1, R-2	150,000 OHM 1/2 WATT RESISTOR	PA-2645
R-3, R-4	1,000 " " " "	MA-2641
R-5, R-6	500,000 " " " "	PA-2535
R-7, R-8, R-13, R-14 R-15, R-16, R-18	100,000 " " " "	MA-2534
R-9, R-10, R-17, R-20	20,000 " " " "	PA-2643
R-11, R-12	30,000 " " " "	PA-2644
R-19	3,500 " " " "	PA-2642

Schematic diagram of Motiograph-Mirrophonic PA-7505-A Amplifier

trast, the tube-type phase inverter arrangement is almost immune to such difficulties, and requires only a few relatively rugged and reliable components.

All stages in the MA-7505-A Amplifier are self-biased by means of resistances inserted in their cathode circuits. If these resistances are not shunted by condensers of considerable capacity some degenerative action, or inverse feedback, takes place within the stage, for they are common to both plate and grid circuits. As has been noted, plate signal voltages are out of phase with respect to grid signal voltages, and hence tend to cancel out part of the stage gain. Where gain is not the objective, this may be beneficial because of the improved stability resulting from this feedback. The phase inverter stage cathode resistor is unbypassed for this reason, and the cathode resistor for the input stage is not only unbypassed, but is used as a coupling element to introduce feedback potentials from the amplifier output transformer secondary winding into the grid circuit of this stage. The feedback circuit will be covered in greater detail in the discussion of the amplifier's frequency response adjusting facilities.

The grid circuit of the input stage includes a voltage divider circuit for balancing the gain of paralleled amplifiers. The gain may be reduced a maximum of 6 db in 2 db steps. There is also an undersized grid coupling condenser which may be connected in place of the regular condenser to cause the low-frequency response of the amplifier to fall off when this kind of response characteristic is needed.

The output transformer secondary winding has taps to give an amplifier output impedance of either 16 or 32 ohms so that one amplifier or two amplifiers in parallel may be directly connected to stage loudspeaker equipment of 16 ohms input impedance without auxiliary impedance matching transformers. The power in the output circuit is represented by relatively high current and relatively low voltage. An extension of the transformer secondary winding to approximately 500 ohms impedance provides additional voltage to enable the monitor stage to be driven to full output even when the main signal output is low. This extension winding is very lightly loaded by the 200,000 ohm grid circuit volume control potentiometer of the monitor stage. There is thus hardly any of the main amplifier output power used for monitor operation, and also no reaction of this control setting on the main ouput circuit.

The monitor stage is conventional in design; the tube used is the 6K6, a somewhat smaller power tube than the type 6L6 tubes employed in the main amplifier output stage. The monitor stage is intended to serve the Motiograph-Mirrophonic SE-7501 Monitor Loudspeaker which includes the output transformer for the stage.

The power supply circuits are also conventional in design except for the metering facilities in the plate circuits of the push-pull output tubes, and for the exceptionally heavy filtering. The rectifier tube is the standard heavy duty full wave type 5Z3. Its output current enters the resistance-capacity filtering network via a large choke coil. The filter network supplies direct current at the proper voltages and with an appropriate degree of filtering to the various vacuum tube circuits, and also supplies the extension plate voltage supply circuit to the associated PA-7505-A Amplifier. The main power transformer has secondary windings to serve the rectifier tube, and separate secondaries for the amplifier tube heater circuits including the extension heater circuit to the PA-7505-A Amplifier. The primary winding is provided with taps to accommodate average power line voltages from 105 to 125 volts. The primary circuit includes a switch located on the top surface of the amplifier chassis for convenience in servicing, and

a special fuse block and fuse, with spare fuse holder, to protect the amplifier against accidental overloads which might be occasioned by tube or other component failure.

All major filter condensers in both PA and MA-7505-A Amplifiers are of the same type, double 8 microfarad units of 475 volt rating. The maximum circuit voltage encountered is in the order of 350 volts, so it is evident that the design allows for a liberal margin of safety. The use of a single condenser type for all circuit positions greatly simplifies maintenance problems, and allows for continued amplifier operation even in the event of failure of one or more individual condenser sections.

A continuous check on the functioning of the push-pull output stage is afforded by the front panel plate current milliammeter and its associated push button switches. From inspection of the schematic diagram it may be seen that the meter normally indicates the sum of the plate currents of the output stage tubes. Depressing the button of the same marking as the individual tube to be checked shunts the plate current of the other tube around the meter so that it thus indicates the individual tube plate current. This permits the output stage to be accurately balanced by selection of tubes, and the meter readings are a check on tube condition and on the performance of the rectifier-filter circuit.

Feedback and Frequency Response Equalization

Many of the early theatre amplifiers had flat frequency response characteristics, that is, all of the various frequencies making up the complex signal were amplified equally. What is desired, however, is an overall system characteristic which will result in the best possible sound quality in the theatre auditorium from the stage loudspeakers, taking into account the nature of the film recording characteristic, the performance of the loudspeakers themselves,

Rack mounted amplifier equipment of Motiograph - Mirrophonic M-911-Dual Sound System

auditorium acoustical conditions, and various other factors. With flat amplifiers the required system response must be established by appropriate filter networks either ahead of the amplification or following it. These add appreciably to the complexity of the sound system, and may have an adverse effect on the signal to noise ratio if they are improperly located in the sound circuits.

The trend in modern theatre amplifiers is toward making the amplifier circuits perform the necessary frequency response equalization. If this is done in the final amplifier stages, an improvement in the signal to noise ratio results because the required drooping high frequency response characteristic acts to attenuate the high frequency components of random noise voltages originating in the input stages. Only a few additional components in the amplifier are required, and it is relatively easy to make the response characteristic adjustable over a fairly wide range so that the sound system may be exactly equalized to suit the acoustical qualities of the auditorium.

In the discussion on feedback it was brought out that feedback acts to reduce the gain of the stage, or stages, within the feedback loop. If the feedback circuit is now arranged to have a transmission characteristic which is not flat with respect to frequency, the response of the complete amplifier to different frequencies will be affected in an inverse manner. At frequencies where the amount of feedback is small, the amplifier response will be high, and conversely, at frequencies where the amount of feedback is large, the amplifier gain will be low. It is, of course, necessary to see that there is sufficient feedback at all transmitted frequencies to insure that the benefits it is capable of producing are realized.

Frequency response controlling facilities in the MA-7505-A Amplifier are of the type just described. Feedback voltage is secured from the 32 ohm tap of the output transformer secondary winding, and it is applied to the input stage grid circuit across the cathode resistor for this stage. A large-capacity series condenser prevents the short-circuiting of the grid bias voltage developed in this resistor, but does not interfere with transmission of the feedback voltages. Rising high frequency response characteristics are produced by shunting to ground part of the feedback voltages through small condensers tapped to a suitable point on the series resistor group which establishes the amount of feedback. The basic H.F. response curves obtained in this manner, and the normal H.F. response curve obtained with no shunt condensers may be modified downward by means of the adjustable resistance-capacity network in the plate circuit of the input tube.

A rising low frequency response is secured by connecting small series condensers in the feedback loop. Various degrees of falling L.F. response are secured by combining this effect with the extreme fall in L.F. response produced by substituting for the regular input coupling condenser the undersize unit previously mentioned.

With none of the adjusting facilities in use, the normal response of the 7505-A amplifiers, operating with SH-7500 Motiograph-Mirrophonic Reproducers, and with specified lengths of connection cable between reproducers and amplifiers, is approximately correct for the Motiograph-Mirrophonic loudspeaker equipment used in current sound systems when they are installed in auditoriums with reasonably good acoustical qualities. The response is established by the reproducer characteristics, the effects of connection cable capacity, and by the general circuit design of the amplifiers. It is virtually flat from 50 to about 3,000 cycles per second, and rolls off at an increasing rate thereafter to be about 15 db down at 8,000 cycles. From good quality film recordings this electrical characteristic gives reproduced music of excellent tonal balance, pleasing and natural reproduction of speech, and very realistic rendition of sound effec and other incidental sounds.

Loudspeaker Equipment

Its Application in Theatre Sound Systems

By GEORGE RAY

Modern theatre sound reproducing systems can be divided into three main groups of components:

1. The mechanical portion—the sound reproducers, familiarly called "sound heads."
2. The amplification system.
3. The loudspeaker system.

Sound reproducers are combination mechanical, optical and electrical devices which produce an electrical signal voltage varying in magnitude and frequency in a manner corresponding to the light transmission characteristics of the recorded sound track on the moving sound film. This signal voltage is used to control the action of the amplification system, which produces relatively large electrical currents varying in like manner. These currents are carried by means of wires to the loudspeaker system on the theatre stage, and it is the function of this latter equipment to convert the electrical energy represented by these currents into sound energy and properly distribute it over the seating area of the theatre.

In the following paragraphs we will attempt, in relatively non-technical language, to show how a modern loudspeaker system functions, as well as the various factors involved in the design and manufacture of systems capable of delivering to theatre patrons faithful reproductions of the sounds associated with the original picture action.

The Two-Way Loudspeaker System

All modern theatre sound reproducing systems made by the major manufacturers employ what is known as the two way loudspeaker system. Such loudspeaker systems, when made up of well designed and carefully manufactured components, give vastly superior sound performance to the loudspeaker systems of the one-way variety utilized in most home radios and in many old style theatre sound reproducing systems.

The two-way loudspeaker system consists of the following major components:

One dividing network (also known as a "crossover" network)
One or more high frequency speaker units
One or more low frequency speaker units
One or more high frequency horns
One or more low frequency folded horns or baffles.

In systems utilizing electro-dynamic high and low frequency speaker units, one or more power units might also be classed as being part of the loudspeaker system.

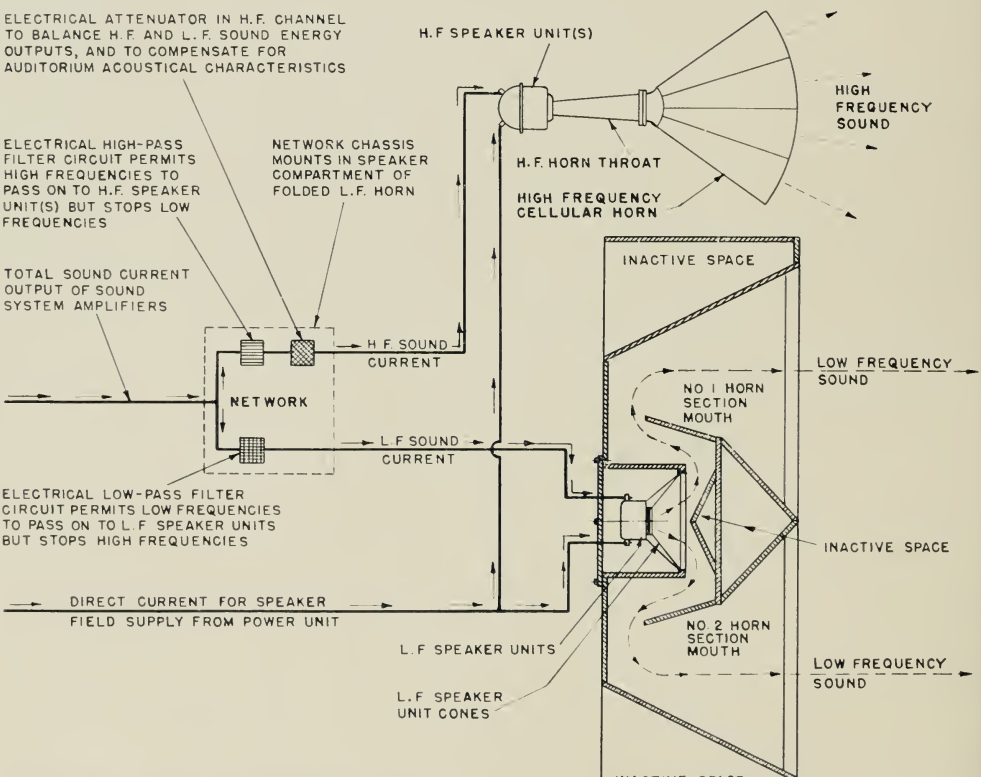
Function of the Dividing Network

The electrical energy from the sound system amplifiers is divided into high and low-frequency portions by a simple electrical filter, commonly referred to as a "dividing" or "crossover" network. By the frequency discriminating action of coils and condensers, the lower frequencies are diverted into the low frequency channel, and the higher frequencies are similarly diverted into the high frequency channel. The frequency at which the two channels receive equal amounts of energy is called the "crossover" frequency, because for a continuously varying tone the sound output would appear to "cross over" from one channel to the other at this frequency.

Where there are neither size nor cost limitations on the high frequency speaker assembly, the crossover frequency is usually in the order of 300-500 cycles, since both the low frequency and high frequency channels can be made to have good performance in this region. Where there are space and cost limitations for the high frequency speaker assembly, the crossover frequency is usually selected to be in the range of 500-1200 cycles so that the high frequency horn can be smaller in size.

High and Low Frequency Speaker Units

All loudspeaker units (i.e., high and low frequency units and monitor speaker units)



FUNCTIONAL BLOCK SCHEMATIC DIAGRAM OF MODERN TWO-WAY LOUDSPEAKER USING FOLDED L.F. HORN AND CELLULAR H.F. HORN

CROSS SECTION OF FOLDED HORN

commonly used in theatre sound systems operate on the same principle. A coil of wire, placed in a magnetic field and carrying an electrical current varying in magnitude and direction of flow, will tend to travel in a direction and to a degree proportional to the direction of current flow

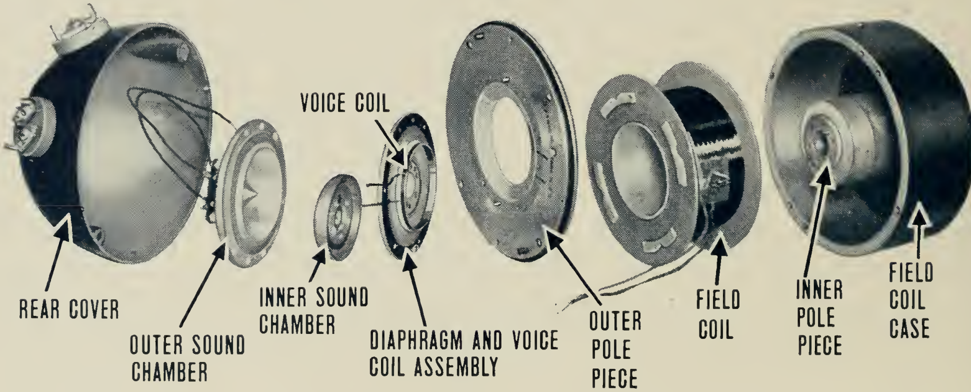
High and low frequency speaker units used in Motiograph-Mirrophonic Sound System models

and the current magnitude. If this moving coil is attached to a diaphragm or a paper cone, the air in the vicinity of the diaphragm or cone will alternately be compressed ("squeezed") and rarified ("stretched") by the movement of the diaphragm or cone. These regions of "squeezed" and "stretched" air move outward from the moving diaphragm or cone and constitute the "sound waves" to which our ears respond. To reproduce the higher frequencies, the moving diaphragm of the high frequency unit should be small and light so that it can faithfully follow the very rapid current variations in the attached coil (commonly called the "speech" or "voice" coil). At the lower frequencies, however, for a given amount of power the diaphragm range of travel is so great that unless the diaphragm or cone is made heavy and rugged, it will be capable of converting only a small amount of electrical energy into sound energy.

These conflicting requirements can, of course, be compromised to some extent by restricting either the amount of power to be handled or by accepting a limited range of frequency response in a unit which must reproduce both high and low frequencies, either of which is undesirable. In the two-way loudspeaker systems this necessity for compromise is eliminated.

The metal diaphragm of the high frequency unit must be well designed, manu-

factured and tested to give maximum performance. It is really surprising when acoustical measurements are made, to note what a vast difference there is in the performance of the various metal diaphragms. Where molded plastic diaphragms are utilized, measurements of performance clearly show they are far less satisfactory than metal ones due to their large irregularities in response to different frequencies. Thus, what appears to be an insignificant item is really an important factor in obtaining quality sound performance.



Disassembled Motiograph-Mirrophonic standard high frequency unit

Baffles and Low Frequency Horns

Low frequency speaker units by themselves cannot properly reproduce all the low frequencies, so they are usually associated with various types of baffles or horns, customarily constructed of plywood braced and reinforced to prevent vibration and warping.

One type utilized in sound systems designed for small and medium sized theatres is known as the "bass-reflex-baffle." The bass-reflex baffle is a box that encloses the rear of the cone of the low frequency speaker unit. The face of the cone, of course, is not covered and there is also an additional opening in the face of the box above or below the cone. The bass-reflex baffle, in effect, twists part of the "sound waves" which come from the back of the cones in such a manner that they add to the "sound waves" coming from the front of the cones. The combination of a bass-reflex enclosure, a large and efficient low frequency speaker unit, and medium sized flatwing baffles makes a very good low frequency channel for small and medium sized theatres.

The action of horns in intensifying and directing sound is familiar to everyone. Various musical instruments such as cornets and tubas are examples. Actually, horns are "coupling" devices, for by means of their confined column of air they enable a small diaphragm or cone at the throat end to set in motion a large mass of air at the mouth end. The lowest frequency a horn can efficiently reproduce depends upon the size of the mouth opening and upon the length and shape of the confined air column. Horns to reproduce frequencies as low as 40 to 50 cycles must be very large.

In order to conserve stage space, the throat portions of such horns are usually folded. Well designed folded horns are among the most efficient types, and they can be designed so that there is very little sound emitted at the rear to cause troublesome reflections from stage walls. One

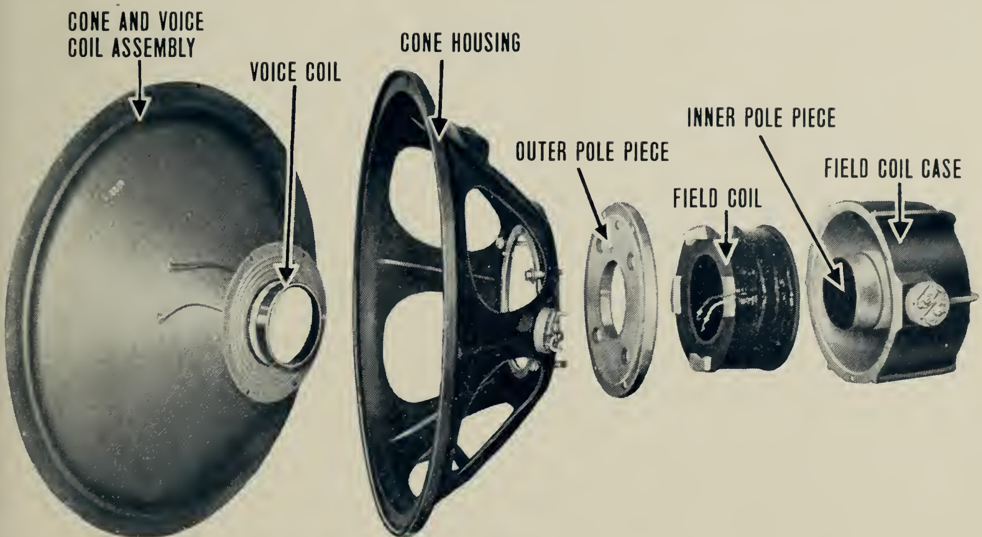
or more folded horns are usually utilized in loudspeaker systems designed for use in the larger theatres.

The High Frequency Horn

A high frequency horn, a high frequency speaker unit and a horn throat constitute a complete assembly that reproduces the high frequencies of the sound originally photographed on the film. Since the high frequency horn does not have to reproduce the long wave length low frequency sounds, it can be relatively small in dimensions. To obtain good high frequency distribution, a number of these small horns can be connected to a common throat and be angled in various directions to provide virtually uniform distribution of the high frequency sound energy over the seating area. Substantially equal results can be secured by dividing a single larger horn into cells with metal partitions of the proper shape and dimensions. Since the higher frequency sounds tend to be absorbed by soft materials, the better quality high frequency cellular horns are usually made of metal.

Necessity of Matched Units

Now that the function and make-up of the individual components of a two-way loudspeaker system has been explained, it is important that they be considered as a group to obtain a complete understanding of the two-way loud speaker system.



Disassembled standard low frequency speaker unit (18″ diameter) of Motiograph-Mirrophonic Sound System line

While the principle of operation of loudspeaker equipment is simple, it is a very difficult and complicated job to produce loudspeaker equipment which will efficiently convert a wide range of electrical frequencies into sound energy, particularly where considerable amounts of energy are needed to make the sound loud enough to hear comfortably over a considerable area.

Low frequency sounds from either horns or baffles are relatively non-directional, that is, they spread out fairly well all over the area in front of the horn or baffle. This is, unfortunately, not true of the higher fre-

quencies; they tend to be confined along the axis of the speaker unit in the baffle, or along the longitudinal axis of the horn. Anyone can verify this by noting how much more crisp and clear the quality is directly in front of a radio set speaker than it is some distance off to the side. In theatre work, where the aim is to provide good sound quality at every seat, this problem of high frequency distribution is very important. Two-way loudspeaker systems solve this distribution problem, in addition to eliminating the need for compromising the efficiency of speaker units to enable them to reproduce both high and low frequencies.

What to Look For in Buying

The lack of facilities and technique for checking up on the performance of loudspeaker equipment in the field leaves a way open for sound system manufacturers to skimp on loudspeaker equipment and yet claim the system to be suitable for large theatres because of the power rating of the

Rear view of lowest cost Motiograph-Mirrophonic loud speaker system, employing bass-reflex cabinet with wings, one high and one low frequency unit and a five cell multicellular horn

amplifiers. It thus behooves the prospective purchaser of theatre sound equipment to thoroughly check into the types and quantities of loudspeaker equipment included in the various systems being offered. Quite often the only differences in numerous models of a sound system line are in the number, size and quality of the components comprising the loudspeaker equipment included.

In general, the loudspeaker equipment of a really satisfactory sound system must include a sufficient number of both high frequency and low frequency speaker units to permit the use of full amplifier power without danger of damage to the units, and without having the units operating so near their over-load points as to produce distortion even more detrimental to good sound quality than any distortion originating in the amplifiers. The relationship between the number of high frequency and low frequency speaker units must be such that the acoustical output of the equipment is well balanced, and the overall efficiency kept high by good design and careful manufacture so that the maximum amount of elec-

Front view of low cost Motiograph-Mirrophonic loud speaker system

Front view of loud speaker system (Motiograph-Mirrophonic M-911 Dual and M-11 Dual)

trical energy from the amplifiers will be converted into sound energy. The equipment must be capable of efficiently reproducing all of the frequency range recorded on the sound films, and the horns and baffles included must be able to adequately distribute the sound energy to every seat in the theatre.

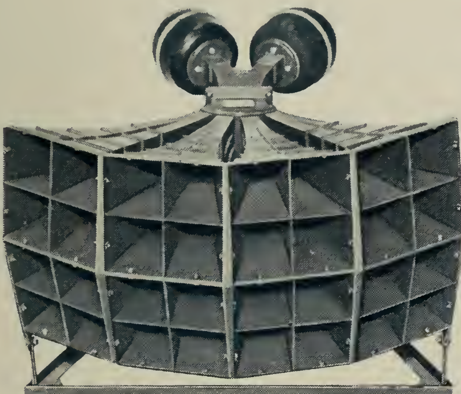
Permanent Magnets and Electro-Magnets

It was previously stated that the functioning of all commonly used loudspeaker units depends upon the interaction between the fluctuating magnetic field produced by the sound currents flowing in the unit's voice coil, and a steady magnetic field in which the voice coil is placed. This steady field may be produced by permanent magnets or by electro-magnets, which are coils of wire carrying direct current, and wound over soft iron cores to confine and direct the magnetic force around the voice coil. The direct current is usually supplied from the same rectifier-filter device ("power unit") which furnishes direct current for operation of the sound reproducer exciter lamps, although in a few of the larger sound systems an auxiliary power unit is provided for this purpose.

Evolution of Two-Way Systems

Most of the early theatre sound systems fed the entire amplifier output into medium sized cone speakers mounted in flat baffles, or into diaphragm type units mounted on large horns. The results were reasonably satisfactory at the time, for the frequency range then being recorded on the film was seriously restricted by various imperfections in the recording equipment and in the film itself, and the trend toward higher amplifier power for increased screen realism had not yet been developed. With the advent of better quality recording, these inadequate speaker systems became the limiting factor in improving theatre sound quality. The modern two-way loudspeaker systems were

therefore developed in which the energy from the amplifier is divided electrically into low frequency and high frequency portions, with these portions then being fed to appropriately designed units for converting each portion efficiently into sound energy. Radical improvements in performance result, and virtually all of the good quality modern loudspeaker systems are constructed on this "two-way" principle.



Front view of 32 cell multicellular horn

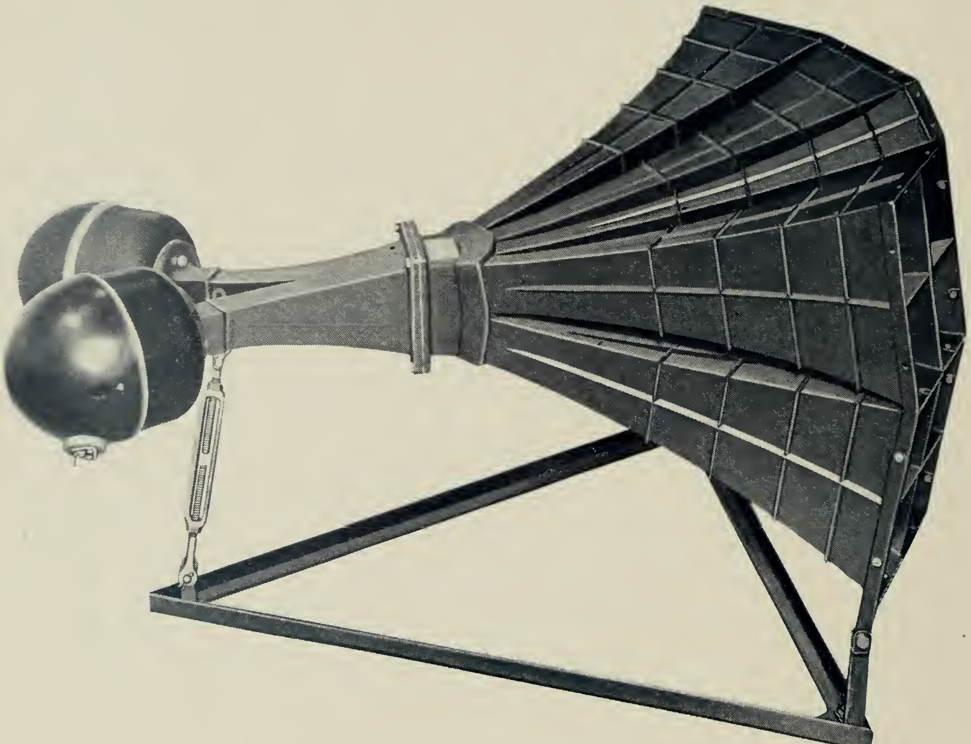
The first two-way loudspeaker systems employed as high frequency units the same types which were previously used to reproduce, after a fashion, the whole range of frequencies then being recorded. While these systems were superior to the old single channel types, very much improved performance was later obtained by designing both low frequency and high frequency units for best efficiency and lowest distortion in the frequency range to be covered by each. Low frequency units could be made large in size and rugged in construction, while specially designed high frequency units with very light but rigid metal diaphragms, self-supporting voice coils, and very small clearances for high efficiency and low distortion became available.

Modification Undesirable

The practice of adding this bit of apparatus here, and modifying that piece of apparatus there, in an old sound system is certainly an unwise one, for it is obviously impossible in this manner to secure the well

Rear view of loud speaker system, with standard equipment of Motiograph-Mirrophonic Models M-911 Dual and M-11 Dual—folded horn, two low frequency and two high frequency units, and 32 cell multicellular horn

balanced and matched performance of completely new equipment. It is likewise risky to attempt the replacement of complete groups of components, such as reproducers, amplifiers and loudspeaker equipment. In almost every case where this has been tried the results have been decidedly inferior to those obtainable from a well designed and properly matched complete sound system, because it usually proves impossible to adjust exactly the operation of the old equipment to give the best possible performance from the new. Rejuvenation of theatre sound systems is seldom any more successful than similar operations on the folks who own and operate them.



Side view of 32 cell multicellular horn with double horn throat and two high frequency units

At the present time, Academy recommendations for the proper size sound system for a theatre of given seating capacity are based upon the electrical energy output of the system's amplifiers at two percent distortion. The recommendations assume that the sound system's loudspeaker equipment will be at least as efficient (that is will have as much acoustical energy output per unit of electrical energy input) as were those of the good quality sound systems which were used for the extensive listening tests upon which the recommendations are based. It would be better, of course, if the ratings could be based directly upon measurements of the actual acoustical energy

coming from the speaker systems, for it is this the audience really hears, but unfortunately it is exceedingly difficult to make such measurements under field conditions and have them bear any relationship to similar measurements made under a different set of conditions.

Need of Matched Sound Equipment

Important as is the design of individual component items in loudspeaker equipment it is far more important to good performance that all components be designed and manufactured so that they will work together properly. Furthermore, it is equally important that the loudspeaker equipment be suitably matched to the rest of the sound system, particularly in the respect of being able to handle the full power output of the amplifiers without excessive distortion and possibility of damage to the loudspeaker units. It must also be capable of properly distributing the sound energy evenly over the theatre seating area.

It is only through including in the sound system well designed and quality built reproducers, amplifiers and loudspeaker equipment that the theatre audience can hear sounds as the studio director and technicians conceived them. Inadequate sound reproduction can ruin an otherwise excellent picture, whereas sound properly reproduced adds greatly to the entertainment value of the motion picture's action—and that pays dividends at the boxoffice.

"When you sold me this theatre you told me it was a going business."
"Well, it's gone, isn't it?"

"*The Voice of the Theatre*"

Altec Line of Loudspeaker Equipment

By FRED C. MATTHEWS

A major development in sound reproduction by Altec Lansing Corporation is a group of loudspeaker systems known as "The Voice of the Theatre."

There are different models of this loudspeaker system line utilizing high and low frequency units, high frequency multicellular horns, and the same type of low frequency horns, so the quality of the equipment furnished for smaller and medium-sized theatres is identical to that furnished for the very largest.

High Frequency Speaker

COMPONENTS AND DIMENSIONS OF LOUDSPEAKER SYSTEMS

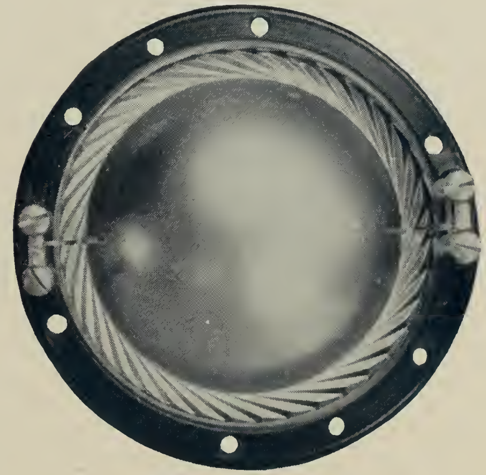
Model No.	No. of L.F. Units	No. of H.F. Units	Dimensions (inches) H	W	D
800	1	1	67	50	23
A-5	1	1	108½	73½	35½
A-4	2	1	108½	80½	39½
A-4X	2	2	108½	80½	39½
A-2	4	2	108½	120	39½
A-1	6	2	108½	152	39½
A-2X	4	4	113	120	39½
A-1X	6	4	113	152	39½

HF Speaker Features

Perhaps the most important feature of the new high frequency speaker of the "Voice of the Theatre" is a design which utilizes the advantages of the new Alnico 5 type permanent magnet. The design of the new speaker in combination with this new type permanent magnet permits high efficiencies at one-third the size and weight of material. It also provides a compact self-energized speaker which needs no separate field supply.

Equally important is the feature of using edgewise wound, aluminum ribbon wire in winding the voice coil. This aluminum ribbon wire, treated with a temperature resistant varnish, greatly increases the efficiency by providing more conductor material in the magnetic circuit.

Another feature is the almost perfect piston action of the metal diaphragm resulting from the use of tangential rather than the usual annular edge corrugations. A recently developed hydraulic drawing technique permits the use of this design, and the greatly increased compliance, or flexibility, provides for larger power handling capacity at low distortion and with adequate safety factor over an extended frequency range. Metal diaphragms are well known to be more sensitive and more even in response than those made of paper or other fibrous materials. The complete voice coil and diaphragm assembly is mounted in a cast bakelite ring. Dowel pins assure perfect alignment. Impedance of the speaker is approximately 24 ohms over



High Frequency Replaceable Diaphragm

The high frequency replaceable diaphragm unit of the Voice of the Theatre with hydraulic drawn aluminum diaphragm and tangential compliance, ribbon wire, bakelite frame and holes for mounting.

a wide frequency range when operating under normal conditions.

HF Multi-Cellular Horn Features

The new high frequency horns are novel in design, rigid in construction and perfect in performance. A large selection of cell sizes and configurations provides high quality sound reproduction and distribution in accordance with the individual architectural and acoustical requirements of each theatre.

To guarantee perfect practical performance of the "Voice of the Theatre" loudspeaker systems, parallel type, constant resistance dividing networks are provided with each system. Crossover point is at 500 cycles. Provision is made for four steps (1 db each) of attenuation in the high frequency output. This is accomplished by changing the shorting strip held down by three screws. Input impedance of the unit is 12 ohms.

LF Speaker Features

Much of the improved low and middle frequency reproduction is due to exclusive design features in the 15 inch cone type driver unit. Its heavy Alnico 5 field magnet and edgewise wound, 3 inch diameter, copper ribbon voice coil combine to produce a unit of exceptional efficiency and ruggedness. The seamless moisture resistant cone has an effective driving area of 123 square inches and it is mounted in a heavy die cast frame to insure alignment of the voice coil in the air gap of the magnetic structure. The air gap is completely enclosed by the cone spider and center dome to keep out dust and dirt particles.

The design features are responsible for the unit's large power handling capacity and freedom from distortion. The response is smooth and clean due to the elimination of undesirable transient effects by correct magnetic circuit and voice coil design. Being self-energized, the unit requires no

Low Frequency Speaker

separate field supply and this also results in hum-free performance and decreased operating temperatures. The voice coil impedance is approximately 20 ohms under normal operating conditions.

The low frequency horns of the "Voice of the Theatre" bring a great improvement in low frequency sound production. An airtight, fully enclosed rear section eliminates backstage reverberation and hangover, a short straight air column increases presence, exclusive vertical ports utilize all available sound energy and rigid construction perfects vibration-proof horn walls.

Large Safety Factors

All components in the "Voice of the Theatre" equipment are designed to provide plenty of safety margin for even the most demanding power requirements—now and in the future. The rated power of each loudspeaker system provides for adequate reserve capacity to safely handle infrequent or accidental overloads. It is, of course, important that one does not buy a "Voice of the Theatre" model that does not have sufficient power handling capacity to handle the power output of the system's amplifiers. For proper safety factor, installed amplifier power should not be in excess of the following:

A1-X	200 Watts
A1	100 Watts
A2-X	150 Watts
A2	80 Watts
A4-X	60 Watts
A4	40 Watts
A5	30 Watts
800	20 Watts

Model 800 is a special "Voice of the Theatre" loudspeaker and is recommended for unusually small theatres and review rooms.

Many Important Factors

The natural screen presence of the "Voice of the Theatre" brings to the screen sound effects that are natural and music that is authentic in reproduction.

Every seat in the house is equally reached by the wide frequency range of the "Voice of the Theatre," assuring high intelligibility and easy comfortable listening for every patron. The "Voice of the Theatre" has overcome the barriers of reproducing bass. By spreading out the range of bass frequencies, true character and definition are given to the varying

Model A5, with one high frequency unit and one low frequency unit

values of voices, instruments and sound effects that require proper reproduction in the lower frequencies. The "Voice of the Theatre" presents the reproduction of sound effects as loud or soft, high or low, sharp or dull, as they actually sound in every day life.

The "Voice of the Theatre" projects all

available sound energy into the auditorium perfectly proportioned and free of backstage reverberation or hangover. An exclusive construction feature completely eliminates rear radiation of sound waves.

A short straight air column increases presence, exclusive vertical ports utilize all available sound energy and rigid construction perfects vibration-proof, absorption resistant horn walls.

Matched Sound Systems

These loudspeaker systems should theoretically make possible the improvement of any old existing sound system by the addition of the "Voice of the Theatre" model best suited to the needs of the particular theatre.

In many cases, however, sound heads and amplifiers in older systems have serious faults, such as high flutter and excessive noise and distortion pickup. New loudspeaker equipment in such cases will correct house distribution problems, but it will also make more apparent to the patron such faults originating in other parts of the sound equipment because of the high efficiency and extended frequency response.

All models of the Motiograph-Mirrophonic sound systems produce the same quality sound reproduction. The models vary only in the amount of amplification and/or loudspeaker equipment furnished. All models contain the 7500 sound reproducer built by Motiograph and based on designs of Electrical Research Products Division of Western Electric Company.

Power output ratings are measured at two percent distortion and D.C. excitation is offered in all models.

Following is a list of Motiograph-Mirrophonic sound systems using "Voice of the Theatre" loudspeaker systems.

Model		*Power Output, Watts*	*No. of H.F. Speakers*	*No. of L.F. Speakers*	*Academy Ratings*
M-9-B -	800	20	1	1	Up to 750 Seats
M-9-B -	A5	20	1	1	1000
M-11 -	A5	15	1	1	750
M11 Dual -	A5	30	1	1	1450
M911 Dual -	A4	40	1	2	1900

"Modernizing" the Sound System

By BEN OGRON

More and more, theatre owners are becoming conscious of the fact that the sound systems for which they paid so much money years ago are absolutely incapable of reproducing faithfully the excellent sound recorded on film today.

Theatre owners have the choice of replacing their present sound equipment entirely, or having someone "modernize" their present sound system by replacing the loudspeaker equipment, modifying the amplification system, or by replacing other portions of the system.

Replacement of the entire system seems to be the better thing to do, as consideration of the following facts clearly indicates. The sound systems of the leading manufacturers of sound equipment in the United States and Canada of the immediate pre-war days, and at the present time, are by far better from every standpoint than the equipment marketed prior to 1938 or 1939, even though the cost of the older systems was much higher than the cost of the more modern sound equipment.

Defects of "Modernized" System

A "modernized" sound system simply will not meet either pre-war or post-war standards of performance, for no matter what portion of the sound system is replaced, the other components will not meet performance requirements.

The "modernization" of an old sound system usually does not include the replacement of old sound reproducers with modern ones, and sound reproducers of the old vintages (in fact, some of the 1941 and 1942 soundheads) cannot be modified to properly reproduce "Stereophonic" recordings. Thus, if old sound reproducers are not replaced, the theatre owner will have a sound system incapable of being adapted for new kinds of sound recordings.

It is true that the addition of a modern two-way loudspeaker system will improve materially the sound quality from one of the older sound system models, and it is likewise possible to modify the amplification equipment to give better sound. But even after such additions and modifications are effected, the theatre owner would still have a complete sound system which would be worth less money than the cost of the modernization.

While it is true that modification of certain portions of any sound system may improve its over-all performance, such modification will not bring the standard of performance up to that of a new, perfectly-matched sound system, and may even cause an apparent deterioration of quality. For example, old style sound reproducers produce three to ten times as much "flutter" as do present day reproducers, due to inherent design imperfections impossible to correct. Connecting a modern extended range loudspeaker equipment to a system having such reproducers may actually result in poorer reproduced sound quality, because distortion, noise and flutter originating in the reproducers are thus made painfully apparent to even the average theatre

patron.

Electronic components and electrical connections are not impervious to the effects of age and use. For example, the wiring between the various components of a sound system may become worn, or its insulation may deteriorate from the effects of heat, dirt and oil. Even when some of the wiring is replaced, a rather complicated wiring system usually results, and this makes servicing the system exceptionally difficult.

Much Improved Sound Systems

Modernization of old sound systems by the addition of further components or the modification of existing components results in complications that make service extremely difficult and very costly.

Many old sound systems which have been modified several times over are producing reasonably good sound today, but they are only doing it because of the loving care of an exceptionally good projectionist or an exceptionally good sound service engineer. Should, by chance, those individuals be transferred, the service problem might well become so difficult that in the event of a breakdown, a day or two or more of box-office receipts will be lost. As can be readily appreciated, the loss of a few days' receipts might well pay for the cost difference between a good, reliable, modern sound system and the cost of a modernization job.

Many of the old sound systems are of the single amplifier channel type which offer no provisions for emergency operation. Modern sound systems often have emergency facilities such as dual main amplifiers, two or more high frequency units, or two or more low frequency units which will permit the show to carry on even in the event of failure of one or more of these important sound system components.

Modern sound systems being so much more simple can produce more satisfactory results even with less efficient help than the operation of old-time systems under the direction of projectionists and sound engineers of long experience.

We have no quarrel with the sound system engineer. We believe he is a very necessary adjunct to good theatre operation. But we do feel that the desirability of modernization of existent sound systems has been over-sold, and that in most cases the ultimate operating cost, including these modernizations, will be materially higher than the cost of a new sound system and its subsequent operation. In addition, with a new system, much more satisfactory performance and better sound quality will be obtained.

Of course, it has been sometimes true that a theatre owner who bought a new sound system in the immediate pre-war era has not obtained as satisfactory sound results as he might have obtained with a modernized old sound system. In such situations, it will usually be found that the sound system selected was too small for the size of the auditorium for which it was purchased, and in other cases it would be found that the system purchased contained unmatched or second or third grade components substituted to meet price competition.

Whether you modernize your present sound system or buy a new one, be sure you know all of the facts before letting loose of your money. Consult your theatre supply dealer and your projectionist—they can and will give you good advice. Don't let the lower price tag of the modernization job keep you from buying a complete new sound system, and don't, by all means, buy a new sound system that has unmatched components or one that is too small for your house.

Sound System Maintenance

Causes of Trouble and Their Correction

By R. T. VAN NIMAN

It would be difficult to overstress the value of a regular maintenance schedule for theatre sound equipment. Careful inspection and care of all theatre equipment pays dividends in the long run, but in the case of sound equipment, the work which reduces the possibilities of expensive breakdowns and lost show time brings such large returns that there is little room for argument as to its value. This does not mean, of course, that the equipment should be taken apart and put back together every so often; there is a lot to be said for the practice of leaving equipment alone that is functioning properly. The thing it is desired to recommend is that those responsible for the maintenance of the sound equipment have regular times to check its operation and to test tubes, clean contacts, tighten connections, lubricate moving parts, and do essential cleaning. Many incipient troubles can be located and corrected in this manner before they have a chance to become serious.

Written records of the maintenance work done are very useful in making certain that no part of the system is overlooked. Such records are provided by the national service organizations, and many of the most careful projectionists either keep these reports or keep records of their own. The length of the interval between periodic checkups is not as important as seeing that they really are periodic. A reasonable figure for the average medium sized theatre not running exceptionally long operating hours is once every two months, though some service operations such as lubricating and cleaning certain parts of the equipment must obviously be performed much more frequently than this.

An essential item in a good maintenance schedule for theatre sound systems is the checking of spare parts and supplies on hand. Careful checking will insure that no shortages develop which may result in lost show time. Periodic inventories of spares will enable replacements to be ordered in time to allow for unavoidable delays in deliveries, and if a particular needed item proves to be completely unobtainable, there will be time to arrange for some reasonably adequate substitute.

Study the Equipment

All sound equipment manufacturers provide some technical information with their systems, and several of the more prominent manufacturers supply very complete in-

struction pamphlets. For example, the instructions for the various models of the Motiograph-Mirrophonic sound systems include schematic and wiring diagrams for the component equipment items, conduit and connection diagrams for the complete system, and detailed installation, operating and maintenance information for the system and for the individual pieces of apparatus of which it is composed. All of this material should be thoroughly studied by those who are responsible for operation and maintenance of the sound system. While there is an almost infinite variety of things that can go wrong with electro-mechanical equipment as complex as a modern theatre sound system, the great majority of troubles are due to simple causes, and can be just as simply corrected once the causes are located. There is no greater aid in hunting trouble than a good working knowledge of the equipment, that is, an understanding of the function of each part, a clear mental picture of how the components are interconnected, and a fairly good idea as to the relationship between observed symptoms and their probable causes.

Test Equipment

To do a really good job of checking the performance of a motion picture sound system calls for the use of test equipment which it would be impractical for each individual theatre to possess. For example, the determination of how the system responds to recorded signals of various frequencies involves the use of a calibrated multi-frequency test film and an alternating current voltmeter (an "output" meter) suitable for use on audio frequency voltages. Accurate measurements of system power output can be made only with suitable meters and auxiliary apparatus, and to determine another fundamental system characteristic, the amount of "flutter" in the output signal due to unsteady film motion at the reproducer scanning point requires equipment not always available even to people who make a business of servicing sound systems.

Nevertheless, a great deal can be learned about the performance of a sound system with only very elementary test equipment and a well-trained pair of ears. The first requirement is a "standard" film, that is, a section of sound film that can be kept on hand and be run occasionally for listening tests on the performance of the sound system. The film need not be of top-notch recording quality, though it should not be exceptionally bad recording. Nearly every projectionist accumulates in time short sections of trailers, clips of excess exit music, and perhaps parts of reels with damaged picture areas but undamaged sound track areas. The idea is not so much to have a test film of perfect quality, but to have one which can be learned well enough to serve as a check on the sound system performance.

Standard theatre sound test reels such as those issued by the Research Council of The Academy of Motion Picture Arts and Sciences (1217 Taft Building, Hollywood, Calif.) and by the Society of Motion Picture Engineers (Hotel Pennsylvania, New York, N. Y.) are of course ideal for listening tests, but they are fairly high in cost for individual theatre use. A few hundred feet of sound film obtained in the manner just outlined will serve as a reasonably satisfactory substitute for routine checking in cases where the cost of the standard reels cannot be justified.

With a film of known quality available to be run periodically for listening tests, it is easily possible to detect deterioration in system performance before it has become serious enough to be noted by patrons. Some of the effects to be observed, and the possible causes for them will be outlined in a later section of this article.

Checking System Operation

Next to a reference sound film, there is probably no single item of test equipment more useful in the projection room than a pair of headphones for close monitoring of the sound quality at the output termi-

nals of the amplifier system. Projection room monitor speakers are intended primarily for use in cueing changeovers. They cannot be run at high enough output level to provide for sound quality monitoring without producing serious interference in

Checking for sound output from the Motiograph-Mirrophonic SH-7500 Reproducer by interrupting the light path with a card.

must be fireproof and not too large in dimensions, and unless there is much better than average sound insulation between the projection room and the auditorium, they the auditorium. Partly because of size limitations and partly because low frequencies are hard to stop with insulation, projection room monitor speakers are usually made

with little response below 150-200 cycles, and thus such things as hum pickups, sprocket hole and frame line noise pickups, and other relatively low frequency noises may go undetected even though they may be very objectionable in the sound output from the large stage loudspeakers.

The use of headphones for sound quality monitoring gets around this difficulty very well. Even quite cheap headphones have fairly good low frequency response when they are tightly coupled to the ears, and they have the additional advantage of shutting out whatever machine noise there may be in the projection room. Very few operators like headphones for routine monitoring and changeover cueing because they necessarily restrict movement and may be uncomfortable, but for checking sound quality, a good pair of headphones is hard to beat.

Nearly all that are customarily used with radio equipment are of high enough winding impedance to permit their being connected directly across the sound system speech circuit to the stage loudspeakers, particularly if this circuit is one of rather low impedance (under 500 ohms), as is usually the case. The high impedance windings of the headphones (customarily in the order of 15,000 to 25,000 ohms) absorb a negligible amount of power from the circuit, but due to their high sensitivity, even this small amount of power produces considerable sound intensity when the phones are tightly coupled to the ears. If the intensity proves too great for comfort, as it certainly will if the stage circuit impedance is anywhere near the 500 ohm figure, the intensity may be reduced to any desired level by connecting *in series* with the headphones a suitable fixed or variable resistor. A one-half megohm or one megohm volume control potentiometer connected as a variable resistor is excellent for this purpose.

A very useful accessory for headphones is an extension cord long enough to permit the phones to be worn while the projectionist is at each machine operating position. The effects of film guide roller adjustments, for example, can thus be noted directly, and checks on hum pickups originating in the reproducers can be easily made. One word of caution is in order—the headphones are connected to the output circuit of the amplifier system. If the connection cord, the phones themselves, or the hands of the person wearing them get too close to the sensitive photocell and input circuits of the amplifier system the whole system may go into oscillation as a result of the coupling thus provided between input and output circuits. If the frequency of the oscillations happens to be within the audible range, very disagreeable howling may be evident. Shielding of photocell and input circuits in modern theatre sound systems is so complete, however, that there is little danger of producing this effect unless deliberate efforts are made to introduce the required coupling.

Other Equipment Maintenance

Several of the service operations used as illustrations for this article involve the use of test equipment not ordinarily on hand in the average projection room. For example, good quality combination AC-DC test meters are scarce and relatively expensive, and the setting of reproducer optical systems for maximum high frequency response requires not only suitable frequency film loops and an output meter, but also a considerable degree of skill and experience for best results. Service engineers from the better equipment dealers and the national service organizations carry such test equipment, and except in the event of some emergency, it is usually best to leave the more complex service operations to them.

Every projection room should have small hand tools such as pliers, various sizes of screw drivers and wrenches, and some kind of circuit testing device for the power supply circuits. Such a device can be very simple. If there are no 220 volt circuits to be checked, a single weatherproof socket of

the kind available in dime stores will do very well. With a 25 or 40 watt lamp in the socket, power circuits and their fuses can be tested readily by touching the socket terminal wires to the circuit terminals. Full lamp brilliancy obviously indicates that

Checking output voltages to reproducer photocell circuits from the Motiograph-Mirrophonic PA-7505-A Amplifier. The amplifier design provides simple wiring and thorough shielding of circuits

electrical power is present. Connecting the lamp to the circuit beyond the fuse or fuses provides a quick check as to whether the circuit is intact at the fuse position. This may seem very elementary, but experience has shown that many expensive system breakdowns are the result of blown fuses.

The output circuit to the stage loudspeakers in the Motiograph-Mirrophonic Model M-911-Dual Sound System is conveniently accessible at the amplifier rack for close monitoring of sound quality with headphones and for use in transmission testing.

Properly fused circuits will frequently open because of line voltage surges, rectifier tube flashovers, and other transient conditions, and of course actually defective fuses are sometimes encountered. Unless there is other evidence of circuit fault, it is always proper to replace an open fuse at least once before going on with a search for trouble elsewhere in the circuit.

If both nominal 110 volt and 220 volt power circuits are present in the projection room, the tester should consist of two sockets wired in series. With 110 volt lamps of equal wattage rating in the sockets, full brilliancy will be obtained on the higher voltage circuits, and something less than half brilliancy on the nominal 110 volt circuits. Most maintenance electricians carry such a testing device in their kits. There are more elaborate kinds on the market, but with many of them the user can never be quite sure whether it is the tester or the circuit being tested which is at fault.

Many of the more modern sound systems have metering circuits which provide a continuous check on the condition of vacuum tubes. Where such facilities are not included, and where tube testing is not done by service engineers, tubes may either be removed and tested at local radio stores, or may be tested by the substitution method. The latter test method has much to recommend it, for commercial tube testers are notoriously lacking in agreement. If careful observation and listening tests show no difference in such fundamental system performance characteristics as gain, noise level, and amount of distortion using a new tube in place of an old one, it is reasonably safe to assume that the old tube is still serviceable. Tubes should be considered individually—there is no technical justification for the old theory that all tubes should be periodically replaced because one weak one contributes to the load on others. It is true, of course, that internal short circuits in tubes used in amplifier output stages may cause such heavy current drains that the

Checking sound quality with headphones at dividing network high frequency channel output terminals in stage loudspeaker equipment of Motiograph-Mirrophonic M-911-Dual Sound System.

rectifier tube in the amplifier power supply circuits may be damaged, but, in general, loss of electronic emission due to tube ageing has little effect on other tubes in the amplifier circuits.

Emergency Maintenance Methods

So far this article has been concerned mostly with the discussion of matters having to do with the routine maintenance of sound equipment, that is, maintenance work which is done to keep the equipment in good order and to correct difficulties before they become serious enough to materially affect the reproduced sound quality. This sort of work is quite different than the kind which is called for when the system is actually in trouble, so that corrective measures must be taken immediately to avoid loss of show time.

It has already been stated that a thorough working knowledge of the sound equipment is of the greatest possible aid in hunting down the causes for trouble. Most of the more or less common kinds of faults produce easily recognized symptoms, and by carefully analyzing the symptoms it is possible to narrow the search to certain sections of the equipment. Much valuable time can be saved by such an analysis, and many shows have been saved because the projectionist used a logical approach in finding out what had gone wrong. There are of course some cases where trouble cannot be quickly corrected because complete clearance involves replacement of a component for which no spare is on hand. Such cases are the exception rather than the rule, however, and generally it is possible to locate and cure very quickly all of the ordinary kinds of trouble by going about it in the right manner. Evidence that this is true is afforded by consideration of the ease and speed with which service engineers usually at least temporarily clear emergency calls. Their extensive knowledge of circuits and equipment, plus their ability to quickly analyze the situations they encounter—and not so much the special test equipment they carry—enables them to do this.

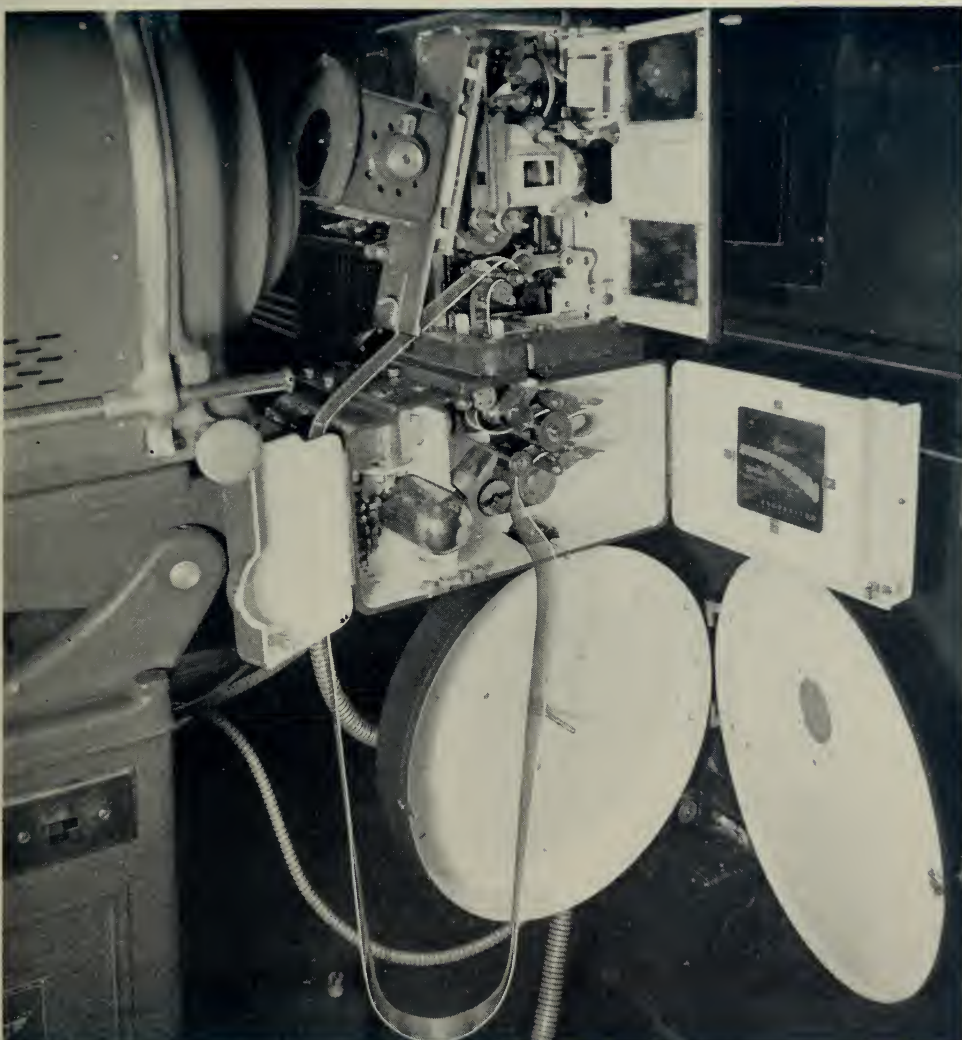
In an article such as this one it is not possible to give any more than very general information regarding the location and correction of trouble. Sound systems vary a great deal in constructional details, and a trouble chart applicable to one type may be almost completely useless for a system of some other kind. Nevertheless, all sound systems used in theatres at present have two or more reproducers or soundheads, amplifiers to increase the weak signals from the reproducers to the degree necessary to operate the stage loudspeakers, and usually some kind of power supply equipment to produce direct current for operation of reproducer exciter lamps and loudspeaker field circuits. The first step in localizing trouble is to determine in which of these major equipment divisions the fault lies, and it is usually possible to do this by considering the symptoms.

If the major symptom is no sound in either the stage or monitor speakers, a logical procedure would involve checking to see that reproducer exciter lamps are lit, and that all amplifier tubes are lit. If they are, it is reasonable to assume that proper line voltage is available at the power supply terminals of the power and amplifier divisions of the system. If tubes or exciter lamps do not light, and if line voltage is available, at apparatus terminals as checked with a circuit tester, the trouble is at once localized within the piece of apparatus concerned.

Once it has been ascertained that there are no visible indications as to the location of the fault, it is then proper to go ahead with a search for less obvious symptoms. Headphones are frequently used to check along the path of the signal through the amplifier equipment, though care must be taken that they are not connected to circuits which also carry direct currents unless a small condenser is used in series with one headphone lead to block the flow of such currents. Contacts and switches in the

sound circuits are possible sources for faults which would result in no sound output, and open windings in transformer coupled amplifiers and open coupling condensers in resistance and impedance coupled amplifiers may also be responsible. Contacts and switches may usually be cleaned and adjusted to restore normal operation, but replacement is required where open circuits occur within components of the latter type.

If all projection room equipment appears to be functioning normally, and if sound output is obtained from the monitor speaker, but not from the stage loudspeak-



Frequency film loop threaded into the Motiograph-Mirrophonic SH-7500 Reproducer for adjusting the lens for maximum high frequency response.

er equipment, it is then logical to suspect this part of the system, or the wires and cables leading to it. Where current for energizing loudspeaker unit field windings

Measuring loudspeaker unit field circuit terminal voltages in the Motiograph-Mirrophonic Model M-911-Dual Sound System. Good low frequency reproduction requires large dimensions and rugged construction.

is obtained from power supply equipment in the projection room, the first thing to do is to check to see that current is actually flowing through these windings. A quick way to do this is to open the field circuit at each unit terminal and note whether a considerable spark is obtained when the circuit is opened. Field windings store energy in their magnetic fields, and this energy is dissipated in the form of a spark or arc at the break point when the circuit is opened. The voltage across the break point may be quite high, even though the normal field voltage is low, so caution should be exercised to avoid contact with current carrying parts.

If the field circuits check to be in good order, the various speech circuits may then be checked with headphones, preferably directly at the loudspeaker unit voice coil terminals so as to include all connecting wires and cables. The frequency dividing networks or filters of two-way loudspeaker systems seldom give any trouble, but all types of loudspeaker units are subject to opens in their voice coil circuits from the effects of overload, corrosion, dust and dirt accumulations, and other causes. Ordinarily such faults must be corrected by replacing or repairing the unit involved, but usually in two-way speaker systems it is possible to rearrange connections so that remaining units will carry the show meanwhile.

Tracing Distortion and Noise

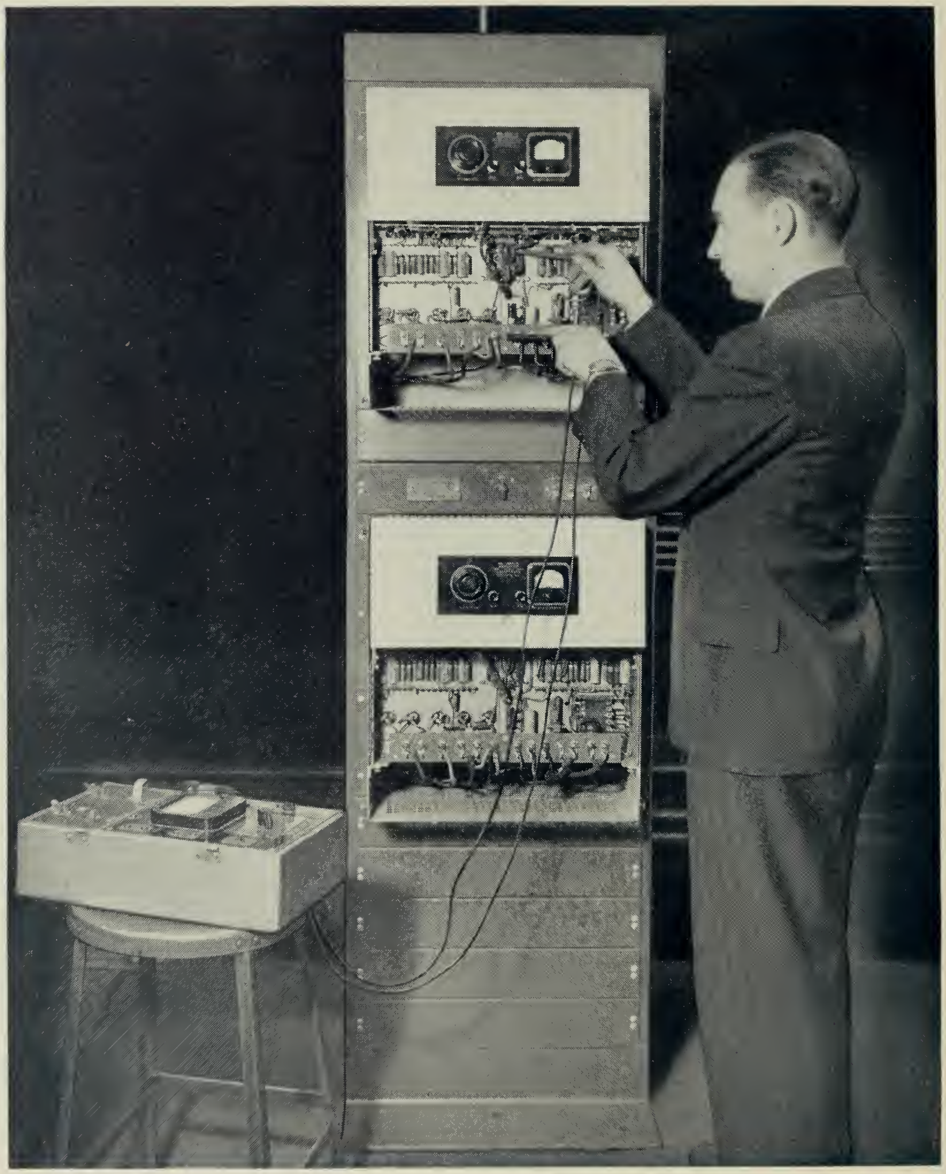
While extreme distortion and very heavy noise or hum pickups can be considered as calling for emergency maintenance procedures, they are seldom quite as serious as having no sound at all. Excessive distortion in the reproduced sound may be due to weak or defective vacuum tubes, failure of some amplifier component, bad connections, damaged loudspeaker units, improper adjustments in the reproducers, and to many other causes including poor sound recording in the film itself. The procedure for tracing down the cause for it is much the same as for hunting the reason for no sound —that is, the more obvious things are checked first, and then the signal is traced through the system with headphones until the point where the distortion takes place

is isolated. Detailed checking at this point will then as a rule uncover the reason for the distortion so that suitable corrective measures may be taken.

Low signal-to-noise ratio in the reproduced sound may be due to any of the causes listed in the foregoing paragraph, or to such things as defective or blackened

Measuring output voltages of the Motiograph-Mirrophonic SE-7520 Power Unit.

exciter lamps, defective or deteriorated photocells, worn and badly scratched film sound tracks, open filter condensers in amplifiers or in power units, etc. A useful procedure in locating the cause for poor signal-to-noise ratio is to first check the amplifier system for noise with all gain controls at maximum and with the ma-



Testing circuit voltages in Motiograph-Mirrophonic MA-7505-A Amplifiers

chines at rest. If the system has individual preamplifiers for each machine, or individual amplifier input stages ahead of the changeover switching facilities, it is helpful to check these one at a time to localize the source of the noise. Sometimes intermittent noises will show up if the various amplifier components, including tubes, and their connections, are tapped with an insulated rod.

If the system is quiet at full gain with the machines at rest, check for excessive machine noise pickup by reducing the amplifier gain to the normal operating point, and operating the reproducers without film. Machine noise pickup should be inaudible, or barely audible at the stage loudspeakers, and if it is found to be more so, the cause should be investigated and corrected. Possible causes are defective or improperly adjusted exciter lamps, excessively microphonic photocells or vacuum tubes in preamplifiers, worn reproducer gears or other mechanical parts, deterioration of vibration absorbing components in the reproducers, poor ground connections, etc.

Abnormally high amplifier volume control settings, usually accompanied by low signal-to-noise ratio, for prints known to be of average recording level are frequently indications of improperly adjusted exciter lamp current, deteriorated or defective exciter lamps, light losses in the reproducer optical system resulting from dirt or oil on glass surfaces, poor adjustments, damaged mirrors and lenses, etc., and of photocells of low or deteriorated sensitivity. Low amplifier gain, particularly in the input stages, due to weak tubes or component failure might also cause these symptoms, but such cases are less common.

Conclusion

The information in this article may be summarized very simply. Regular and routine maintenance work on the sound system is worthwhile in eliminating the causes for breakdowns before they occur. A thorough knowledge of the particular type of system makes both routine and emergency maintenance operations very much easier and quicker. A great deal can be done with very simple and inexpensive test equipment provided the user is familiar with general principles and with the specific kind of apparatus being serviced. When trouble does occur the best way to go about locating and correcting it is to check the more obvious symptoms first, and then proceed with a step-by-step search until the trouble is localized in one part of the system.

If even one or two of the ideas and suggestions in the article prove helpful in just a few cases, the time spent in preparing it will have been well justified. Some day, perhaps, we shall have sound systems that need no maintenance. Designers continually strive to produce equipment of this kind, and comparison of modern sound systems with those manufactured in the early days of sound motion pictures will show that this ideal is being approached more and more closely.

THEATRE ACOUSTICS

Theatre Acoustic Recommendations

Prepared by

THE ACADEMY RESEARCH COUNCIL THEATRE SOUND STANDARDIZATION COMMITTEE

In May, 1941, the Research Council, Academy of Motion Picture Arts and Sciences, published a technical bulletin giving much very useful information for the correct acoustical design of auditoriums to be used as motion picture theatres. This bulletin was rather widely circulated at the time, but we feel that in the present period, with so much new construction and remodeling being planned, the authoritative data it contains will be of general and timely interest, and perhaps specifically useful. The SOUND TRACK is, therefore, happy to have this opportunity to give an even wider circulation to the bulletin, and is grateful to the Research Council for permission to reproduce it.

These THEATRE ACOUSTIC RECOMMENDATIONS are based upon the experience of architects, acoustical and equipment engineers, and studio operating personnel in designing, equipping and maintaining theatres. They were prepared after conferences and discussions between the Committee and prominent representatives of these various groups. Through such cooperation, it is now possible and practical to formulate general principles to guide the acoustic design and construction of motion picture theatres. *These principles, when applied, will improve sound reproduction and minimize or eliminate costly alterations in the completed auditorium.*

In designing a theatre auditorium, the architect is interested primarily in the usefulness and appearance of the finished structure. However, the auditorium shape, and the type, amount, and location of the necessary acoustic materials must guide in the construction and final appearance. From this point of view, some general considerations of acoustics will be outlined, and the application of these principles explained.

REQUIREMENTS FOR PROPER LISTENING CONDITIONS

The acoustical requirements for good listening conditions in an auditorium are that the sound loudness be adequate; that

the components of the complex sound maintain their proper relations; and that the successive sounds in fast-moving speech or music be clear and distinct and that the auditorium be free from extraneous noises. These fundamental concepts are both necessary and sufficient for good listening conditions.

These proper listening conditions are affected by the following physical factors:

(1) Size of the room.
(2) Shape of the room.
(3) Absorption characteristics of the acoustic materials and their placement in the room.
(4) Extraneous noise level present in the room.

THEORETCIAL CONSIDERATIONS

As the optimum reverberation time of a room and the proper control of reflection effects are the two most important factors in proper acoustical design, a brief discussion of these factors follows:

Optimum Reverberation Time

The desirable reverberation time of a room is a function of its size. The effect of moderate reverberation is beneficial as the direct sound is reinforced and a desirable liveness is produced. In general a reverberation time of over 2 seconds (at 500 cycles and under empty hall conditions) should not be exceeded. Excessive reverberation causes blurring of speech and rapidly moving staccato music. Where the reverberation time in the room is below optimum, an excessive amount of sound energy must be radiated, and the resultant sound is unnatural.

The optimum reverberation period varies with frequency and with the size of the room. Figure 1 gives the optimum reverberation time for various sized motion picture auditoriums at frequencies from 50 to 1000 cycles.

Reflection Effects[1]

Many theatres, due to their shapes and

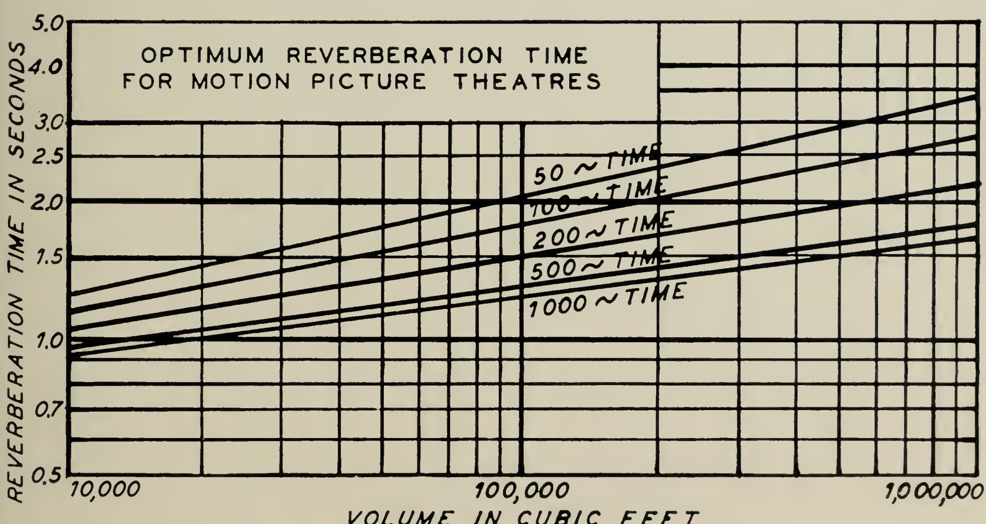


Figure 1

sizes, still have many major acoustical defects which cause echoes and objectionable concentrations by a focusing of the reflected sound. These reflections are in numerous cases of greater importance than the reverberation time.[2]

When a sound wave strikes a wall of a theatre, its energy is partially reflected, partially absorbed and partially transmitted. The reflection, for surfaces large in comparison to the wave length of the sound, is analogous to the reflection of light, and the angle of incidence of the sound is equal to the angle of reflection. The relative amounts of energy reflected and absorbed by a material vary with the angle of incidence and with the frequency.

However, while a doubling in energy is the maximum increase or reinforcement which can take place at any one point, the decreased level or cancellation effect can be infinite. Consequently, any absorption at the point of reflection will tend to decrease the additive and subtractive components, and to minimize the modification of the characteristics of the direct sound.

Control of Reflection Effects

For proper sound reflection control in an auditorium the acoustic treatment and shape of the walls and ceiling must be such as to thoroughly diffuse the reflected sound. In other words, the reflected energy received in any auditorium location should not come from one particular reflecting area but should be contributed by numerous reflecting surfaces. The energy from any one reflection should be small compared to the total reflected sound energy at any point in the auditorium. This also provides a uniform logarithmic decay of the reverberant sound.[3]

Little is gained by attempting to reinforce the direct sound by allowing maximum reflection to take place as any small gain in sound energy may be overbalanced by destructive interference effects.

Optimum Acoustical Design

Two of the most common acoustical defects of a theatre, attributable to poor shape design, are echoes and sound concentrations.[3] These as well as other defects can be avoided, and the optimum characteristics obtained by observing the following general rules (See Figure 2):

1. The cubical contents should be kept to a minimum, consistent with the number of seats required.
2. The auditorium width should be from 50 to 70% of the length, and the ceiling height not more than 40% of the length.
3. Non-parallel surfaces should be used.
4. Convex rather than concave walls and ceiling sections should be provided. The wall and ceiling surfaces should also otherwise be broken up so as to thoroughly diffuse the sound.
5. The average absorption per square foot on the floor and ceiling should not be appreciably different from the average absorption per square foot on the side walls.
6. Well-upholstered seats and ozite-lined carpet in the aisles should be provided.
7. The backstage should be so shaped and so acoustically treated that resonant reinforcements of sound will not be reflected into the auditorium to distort sound quality.

It should be pointed out that the design in Figure 2 is only one method of applying the above principles to obtain an ideal set-up. The fully convex rear wall and the convex sections on the side walls and ceiling are ideal design features, but a design including the three convex surfaces on the rear wall or a design as shown by the solid lines will also give excellent results.

These general rules will be explained in greater detail and illustrations given of good and faulty designs.

SIZE OF ROOM

Optimum Volume

Both from an acoustical standpoint and in the interests of economy, the cubical content or volume of the auditorium should be kept as small as possible, consistent with the required seating capacity and proper proportions of length, width, and height.

In small sized auditoriums it is possible to obtain optimum reverberation conditions without acoustic treatment on the walls and ceiling, provided the seats are fully upholstered, the aisles carpeted, and the auditorium properly designed to diffuse the sound reflections and to provide uniform loudness at every seat in the auditorium.

Recent acoustical design in which the volume has been held to a minimum, without sacrifice of other features, has provided one of the most outstanding improvements in general sound quality in the theatre. From an average of recent trends in design

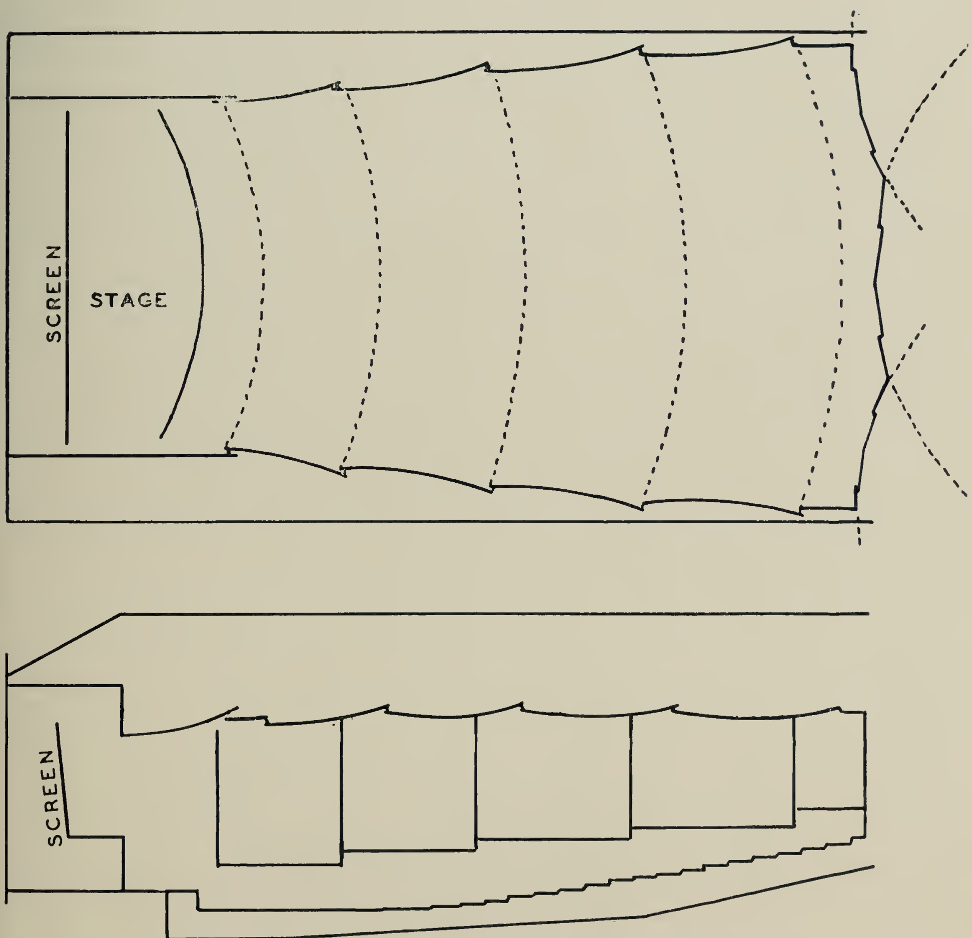


Figure 2

giving satisfactory performance, it has been determined that approximately 125 cubic feet per seat is desirable for a medium sized house.[4] This figure varies with the seating capacity of the auditorium.

Minimum Power Requirements for Theatres

The acoustical power necessary for proper sound reproduction varies with the volume of the auditorium. "Minimum Power Requirements for Theatres" have been established by the Academy Research Council,[5] and are given in Figure 3 in terms of amplifier watts installed.

SHAPE OF ROOM

Recommended Auditorium Proportions

For some time, a proportion of from 50 to 70% between length and width has been considered good.[6] The source of sound is at the end of small dimension. In a room with non-parallel walls or of irregular contours, the above rule may be applied using the average width and length. In those rooms where the length is greater than twice the width, the reflections between the side walls cause serious damage to the quality.

As previously explained, excessively high rooms should be avoided; that is, the ceiling height should be kept to the minimum consistent with the seating capacity and other necessary architectural requirements.

Side Walls

Flat parallel walls in auditoriums of all sizes have always been a distinct source of trouble from both a vision and sound standpoint. In such an auditorium, seats installed in the front corner sections of the ground floor afford only a very distorted vision of the picture and are unsatisfactory to the theatre patron. From a sound standpoint, flat parallel surfaces give rise to disturbing sustained cross reflections. A theatre with a "fan-shaped" floor plan, as shown in Figure 2, offers decided advantages over rectangular designs as better vision is secured, and a basic shape is available which is easily accommodated to a side wall design giving proper diffusion and control of the reflected sound.[7]

Where it is not practicable to use convex side wall surfaces because of economic limitations or difficulties of providing proper lighting, the side walls should be broken up into sloping sections. These sections should be so angled with respect to the high-frequency horn as to reflect the sound well into the side rather than too much into the center of the audience.

Auditorium Ceiling

The ceiling surface should not be parallel to the floor, as such a design results in acoustical deficiencies.

As shown in Figure 2, the ceiling should be designed to secure desirably directed reflections and to eliminate echoes. In all cases every effort should be made to avoid ceiling designs which involve domes or other concave types of construction which focus the sound into the seating area.

Lighting fixtures constructed with loosely held portions of glass or plastic materials should be avoided as such fixtures often rattle, being resonant at certain frequencies.

Auditorium Floor

Well-upholstered and heavily padded seats should be used in furnishing the auditorium. The aisles and corridors should be covered with ozite-lined carpet. This reduces the variation in the reverberation time under different audience conditions.

With upholstered seats and carpeted aisles, it is generally not desirable to acoustically treat the ceiling. Such treatment results in an acoustic condition in which the reverberation time is shorter in the vertical direction; that is, between the floor and the ceiling than between the side walls and the front and rear walls. For optimum acoustical conditions in a room, it is nec-

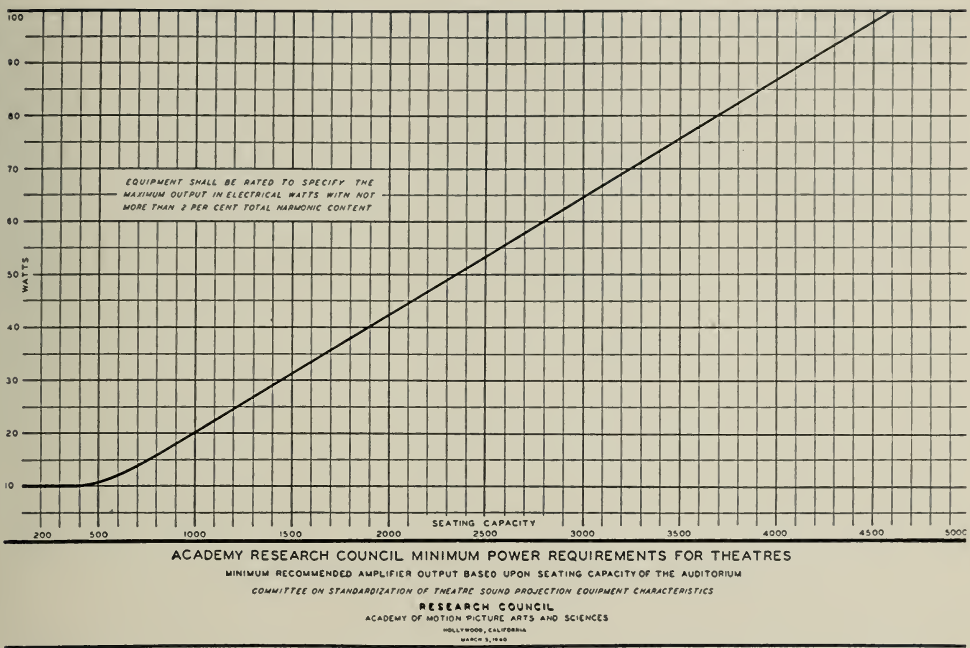


Figure 3

essary that the reverberation die away uniformly in every direction.

Rear Wall Construction

It the past, rear wall construction has often led to serious acoustical deficiencies in the theatre. Unbroken walls have given rise to reflections back into the audience with sufficient magnitude and time delay to be audible as echoes. Concave rear wall construction with consequent focusing of the reflected sound has also adversely affected sound quality. In contrast, convex surfaces provide the highest degree of sound dispersion.

The individual shaping may take different forms but should always diffuse the sound. Otherwise the sound reproduction will lack presence; that is, the voices of the actors will appear to come from a source other than the screen and the illusion of reality, so important to the proper presentation of sound motion pictures, will be lost. A modified convex-type rear wall can be utilized to advantage in order to conserve seating area and at the same time to eliminate the focal difficulties inherent with concave rear wall design. Definite breaks in the contours which would have any tendency to form pockets and produce resonant cavities should be strictly avoided in the rear and side walls.

Illustrations of Bad Acoustical Designs

A typical example of a theatre with faulty acoustics is shown in Figure 4. The auditorium is rectangular in shape with flat parallel side walls, a flat rear wall and a relatively unbroken ceiling. These walls contribute to multiple echoes and a very bad overall acoustical condition. The in-

Figure 4

telligibility of the dialogue is low.

Figure 5 illustrates a side wall section constructed so as to focus the sound into the seating area. The concave wall surface adjacent to the stage focuses the reflected sound into the center section of the seating area, reducing screen presence and intelligibility.

By constructing the front portion of the side wall in a convex shape as illustrated in Figure 6, a properly diffusing surface is provided and the acoustic defects are avoided. The shape of the wall in Figure 6 may be seen by noting the junction of the wall and the ceiling.

Another example is shown in Figure 7, where the ceiling is also flat and unbroken. In this case it was necessary to tilt the high-frequency horn well down into the audience to eliminate reflections from the ceiling. This decreased reflection effects but provided a decided difference in quality between the front and back seating sections.

A recent trend in rear wall construction is shown in Figures 8 and 9. When designed it was felt that such a tilting of the rear wall would reinforce the sound in the back portion of the seating area,

giving a more uniform loudness level throughout the auditorium. Tests have indicated that these constructions are undesirable, as this type of rear wall tends to concentrate low-frequency sound in rear audience areas and contributes to poor sound quality.

As a result of these experiences, such designs are considered impracticable and it is recommended that the rear wall generally be vertical and of such shape as to diffuse the reflected sound and to deliver it back into the audience in random directions. The rear wall must always be considered in conjunction with, and never separately from, the side wall, ceiling, and floor designs.

Application of Good Design Principles

A practical example of the application of these design principles resulting in a theatre with exceptionally good acoustics is illustrated in Figures 10-A, -B, and -C. Figure 10-A shows the rear wall and ceiling construction as viewed from the side of the auditorium. Figure 10-B is a view

Figure 5

from the stage. Figure 10-C is a schematic showing the vertical and horizontal cross sections of the auditorium and the three different rear wall cross sections in detail.

This particular auditorium has been constructed on one of the studio lots and seats approximately 700 people. However, in a commercial application the rows would be closer together, so this theatre may be considered to have a seating capacity of about 1,000.

Although the principles of good design are fulfilled, certain features depart from the ideal given in Figure 2. Fortunately, such deviations may be made without serious penalty. The side walls, while of straight sections, have been broken up to give a series of differently sloped, small reflecting surfaces with the direction of reflection well into the side of the seating area. The same construction has been used on the ceiling. The rear wall surfaces consist of flat area, but the overall contour is convex, and the walls are sectioned in irregular sizes and at different angles so that each section is contributing only a small reflection in any particular direction. It should be noted that all sections of the rear wall are vertical and do not tilt toward the seating area.

Figure 6

Backstage Acoustical Treatment

In the reproduction of sound in the theatre one of the most critical acoustical re-

Figure 7

quirements is adequate backstage draping. In the design of the speaker and its associated unit every effort is made to minimize the amount of sound radiated from the back of the loud speaker. However, a certain amount of "leakage" radiation takes place and must be adequately absorbed. It is realized that efforts along this line have been made by various architects, but in general the absorption provided has not been sufficient.

Although the rear wall of the stage is often covered with rock wool blankets, this material, when applied directly to a brick wall or other hard surface, has been inadequate. In other cases the absorption material has been set out from the wall on furring strips with the absorption material applied to wire mesh stretched across the strips to increase the low-frequency absorption properties. This is far more effective than the former method, but still

does not reduce the backstage reverberation time to the necessary negligible amount.

It has been observed that in a large number of cases this treatment is finished with a white surface, and for proper picture projection results it is suggested that a black covering be used instead to avoid light reflections back to the screen.

Considering the type of backstage absorption treatment normally provided it has been necessary for the theatre owners to completely cover the back of the screen with ozite, with the exception of the space occupied by the loudspeakers.

Suitably located drapes around and above the speaker provide an efficient means of absorbing undesirable backstage sound reflections. However, this type of treatment is an added expense to the exhibitor and some form of speaker draping and screen masking should be combined in the initial design.

Figure 8

Figure 9

In the design of the stage of the auditorium, two factors should be borne in mind. First, for proper viewing and listening conditions the first row of seats should be at least 20 feet from the screen, where the screen is not more than 16 feet in width. For wider screens the first row of seats should be back an additional 15 inches for each foot of screen width over 16 feet. Second, the stage floor should be shaped to give an unobstructed view from the front seats, and the stage area should be covered with a rug or other sound absorption material to eliminate reflections directly from the loud speaker into the seating area.

Figure 10-A

ABSORPTION CHARACTERISTICS OF ACOUSTICAL MATERIALS

The absorption characteristics of commercial acoustic materials vary widely. Some materials also show a pronounced absorption peak in their characteristic. These materials, while highly efficient for certain purposes (absorption of typewriter clicks, for instance), may be detrimental in a theatre as their use produces a non-uniform response.

Materials selected should show a smooth absorption characteristic and materials with adequate absorptivity at the low frequencies should be used. For this reason care should be taken in selecting the material to be used in an auditorium in order that the desired overall effect be secured.

Modern acoustic materials are of such

varied design and construction that it is possible for the architect to apply the proper sound absorption material and at the same time to produce almost any artistic effect desired.

Figure 10-B

Low-Frequency Absorption

Due to the fact that many acoustic materials are deficient in absorbent qualities at the low frequencies, it is often necessary to use these materials in a particular way to effect sufficient low-frequency absorption in the auditorium. To obtain this absorption at the extreme low frequencies the diaphragm action of the walls should be utilized. This action may be explained as follows: Where a wall is not rigidly supported, as in the case of a furred-out wall, it will act as a diaphragm and vibrate at certain frequencies, depending upon the dimension of the wall, the mass per unit surface and the manner of wall support. This diaphragm action may either reinforce or absorb the sound near the particular frequency at which the wall resonates. If the wall has little internal resistance it will continue to vibrate after the original sound has died down and will reradiate energy into the room, reinforcing the original sound.

In contrast to this, if the material has

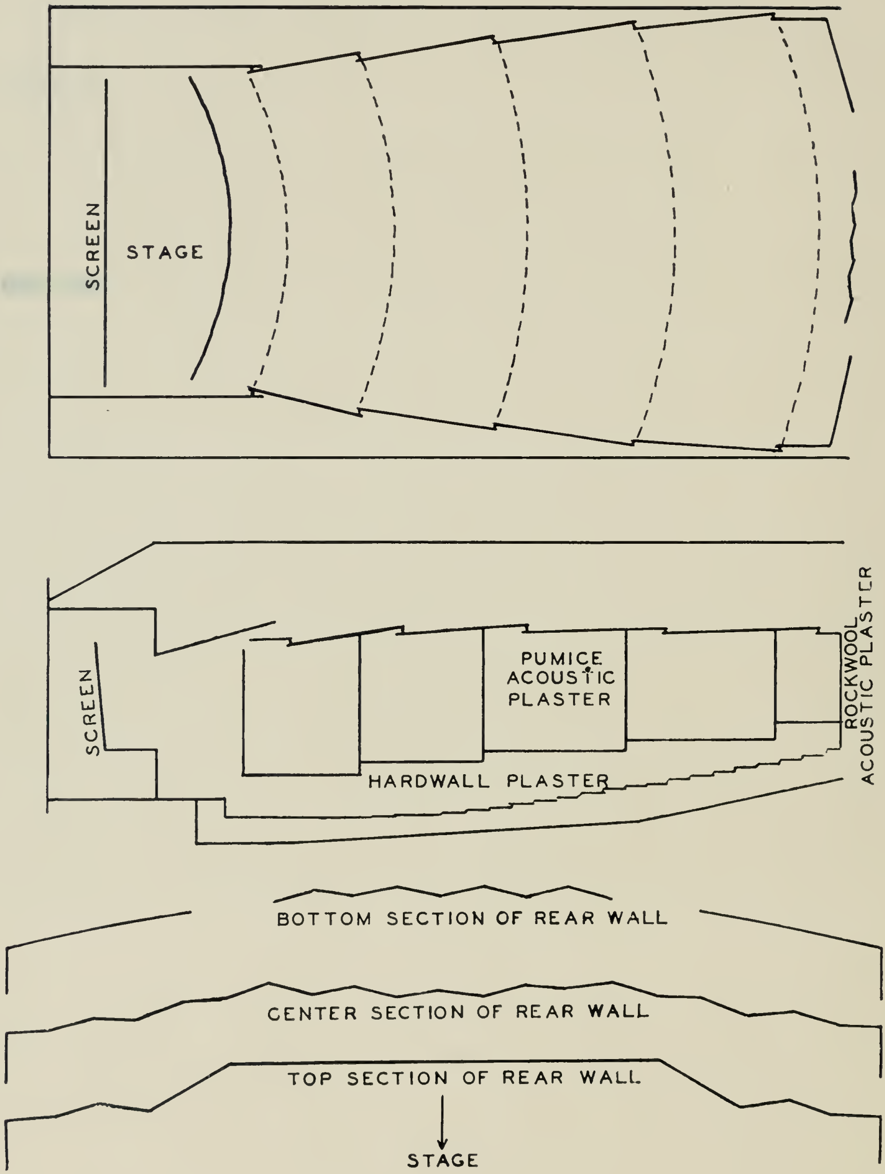

SCREEN
STAGE
SCREEN
PUMICE ACOUSTIC PLASTER
HARDWALL PLASTER
ROCKWOOL ACOUSTIC PLASTER
BOTTOM SECTION OF REAR WALL
CENTER SECTION OF REAR WALL
TOP SECTION OF REAR WALL
STAGE

Figure 10-C

high internal resistance to vibration (as do masonite, celotex and similar acoustic materials) the vibrations will die down faster than the reverberation time in the room and no "hang-over" effect takes place. To avoid a boomy house (which has excessive response in the region from 60 to 300 cycles) it is often advisable to make use of this diaphragm action to absorb these low registers.

In the practical application of such design the furred-out walls should be made into different size sections by irregular bracing of the wall itself. Such construction provides wall sections of different dimensions which absorb the low frequencies through a wider band and avoid dips or peaks in the response characteristics.

Non-symmetrical Absorption Areas[8]

The most recent design considerations have proven the efficacy of using completely non-symmetrical small areas of absorption materials as contrasted with the earlier use of large treated surfaces. This non-symmetrical arrangement tends to maintain the long indirect path reflections and to reduce the formation of surface patterns, resulting in unsatisfactory sound conditions.

The amount of sound absorption material necessary in theatres of various sizes is given in Figure 11. This chart is useful for design purposes.

AUDITORIUM NOISE LEVEL

A theatre, to have good acoustics, should have its walls insulated against the transmission of outside noise into the auditorium.[9] The transmission of sound is of two kinds:

1. Air borne
2. Structural

Small openings around doors, windows, through portholes, etc., transmit sound readily. For this reason all of the joists between walls, doors and windows which lead outside should be made as tight as possible. Transmission of sound through the building structure (such as the noise from vibrating machinery) can be minimized by using double wall and double floor construction where required and by separating all vibrating machinery from their supporting structure with vibration isolating materials such as cork or rubber. Massive walls are not always necessary to obtain sufficient sound insulation. A double wall of fairly light construction will give good sound insulation provided the two walls are not closely coupled mechanically by nails or rigid close members.

A large part of the transmitted noise often comes from the projection booth. For this reason as much fireproof acoustic material as possible should be placed on the inside walls and ceiling of the booth. As much of the projection booth noise is radiated through open portholes or portholes with glass windows, these too should be treated.

It is also recommended that the air-conditioning system be operated at a low noise level, by employing a large volume, slow velocity system.

SUMMARY

In summarizing these THEATRE ACOUSTIC RECOMMENDATIONS reference is again made to Figures 2 and 10, and the foregoing principles presented in outline form.

The essential design features are:

1. A minimum volume consistent with the required seating capacity and proper auditorium proportions.
2. An auditorium width of from 50 to 70% of the length and an auditorium ceiling height of not more than 40% of the length.
3. The use of non-parallel surfaces; in particular, the floor should not be parallel to any ceiling section nor opposite side wall sections parallel.
4. The use of convex rather than con-

cave surfaces. In addition, the wall and ceiling surfaces should otherwise be broken up so as to thoroughly diffuse the sound.

5. Auditorium absorption characteristics to provide the same rate of sound decay in a vertical as in a horizontal direction from side to side or from back to front walls.
6. Heavily upholstered seats and ozite-lined carpet in the aisles.
7. Backstage treatment giving a negligible amount of reflected or reradiated sound from the backstage into the auditorium.
8. A heavily carpeted proscenium designed for good viewing conditions from the front seating section.
9. Auditorium walls with sufficient sound insulation material to prevent extraneous noise entering the auditorium.
10. The projection booth acoustically treated with fire-proof material and projection ports equipped with acoustic baffles.
11. All equipment subject to vibration and hum such as arc generators, voltage regulators, lighting control equipment, etc., acoustically isolated from the auditorium.
12. Air-conditioning equipment of a

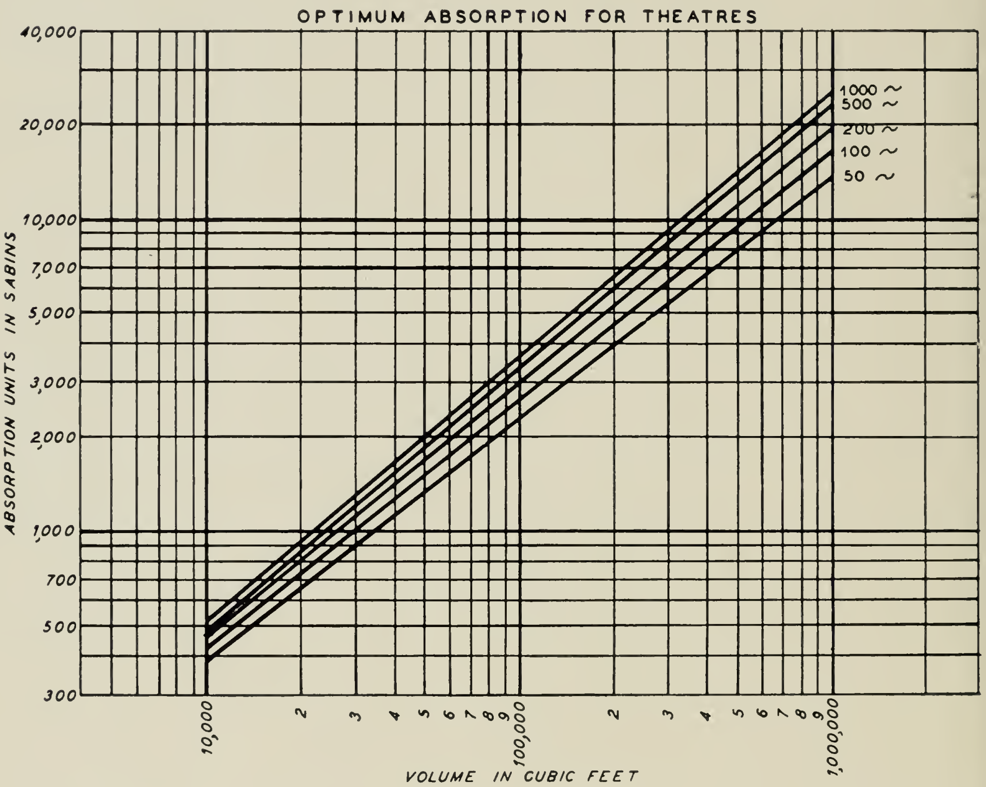


Figure 11

high-volume, low air-velocity type with air ducts provided with acoustic baffles.

Long, narrow auditoriums, high ceilings, excessively long and narrow balcony overhangs, concave focusing surfaces, and large unbroken reflecting areas should always be avoided, as acoustical faults will always result from their use.

If these Recommendations are followed, the resulting auditorium will give sound (as reproduced on a modern two-way equipment) with high intelligibility, warm, natural screen presence, good balance between high and low frequencies, uniform loudness level throughout the auditorium and the proper relative balance between high level music passages and low level, intimate dialogue scenes.

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Acoustical Materials

And Their Use in the Theatre

By GEORGE P. LITTLE

A theatre that is perfectly constructed from an acoustical standpoint and possesses a well made and well suited sound system would be free of any sound problems. The blame for poor sound may therefore be sought either in the sound equipment or in the theatre acoustics.

Equipment and Acoustics

The trouble with many sound systems is that they are not suited to the particular theatre, that is to say, to its cubical content, its shape or its seating capacity. If the sound equipment is at fault, the theatre owner should replace it at the earliest opportunity, and secure competent professional advice when purchasing a new system.

But the sound system may not be at fault. In thousands of theatres in the country, the sound is harsh or unintelligible to a considerable portion of the audience, in spite of adequate sound equipment. When this is the case, we know at once that we have a problem in theatre acoustics.

May I pause to remark that there are a good many theatre owners who do not know that they have poor sound. I suppose it is only human nature for an exhibitor to be prejudiced in favor of his own theatre, and to take it for granted that his projection and sound are as good as that of anyone else. If you have the slightest suspicion that your sound is not what it should be—and your box office receipts may well give you such a suspicion—it is high time to consult some independent opinion. Ask your theatre equipment dealer, your projectionist, your sound service man, the good wife and a dozen or two of your patrons. You'll get plenty of varied opinion, I know, but at least those opinions may indicate that you ought to do something about your sound.

Poor sound keeps people away from the boxoffice. Your choice of good pictures, your excellent projection, may be entirely nullified by bad sound. The best picture will be ruined by loud blatant noise which makes dialogue unintelligible, by reverberating echoes, or conversely, by weak sound or actual "dead spots." People come to the theatre for enjoyment, and if you have nothing better to give them than a case of irritated nerves, you can be pretty sure that they will stay away from your theatre in droves.

The Meaning of Acoustics

Now that we appreciate the importance of good sound, what can we do to improve theatre acoustics?

Webster defines "acoustics" as "The science of sound, including its production, transmission and effects, and the sum of the qualities that determine the value of an auditorium as to distinct hearing." If you are to determine the acoustical value of your theatre, you must examine the sum of its acoustical qualities.

Poor sound comes partially from poor acoustical conditions—hard plaster walls, veneer seats, lack of sufficient draperies and carpets, straight walls and ceilings, in-

Theatre wall panel, showing interesting application of perforated acoustic tile.

correct relationship of ventilation to sound —to name a few.

Many theatres, due to their shapes and sizes, have major acoustical defects which cause echoes and objectionable concentrations by a focusing of the reflected sound. When a sound wave strikes the wall of a theatre, its energy is partially reflected, partially absorbed and partially transmitted. If the cause of the trouble is a curved surface, such as a dome, it may not be possible to obtain a complete correction by the use of acoustical material alone. In such cases, the reflected sound will be weaker, but the focusing effect caused by the curvature of the dome may still give some trouble. Covering up the dome with a flat suspended ceiling may be necessary for complete correction.

Acoustical Materials

In most cases, theatres that suffer from

bad sound can obtain satisfactory correction from the installation of acoustical material.

Care should be taken in selecting the acoustical materials to be used in a theatre. The materials chosen should show a smooth absorption characteristic, in order that the desired overall effect may be secured.

Acoustic tile applied between pilasters on side wall.

Modern acoustic materials are of such varied design and construction that it is possible for the architect to apply the proper sound absorption material and at the same time to produce almost any artistic effect desired. While the principal function of acoustical materials is to absorb sound, they have come to be considered as a highly desirable and attractive interior finish on walls and ceilings.

There are four general classifications of acoustical materials:

1. Rigid units or "tiles."

2. Flexible felts and blankets, with separate coverings of perforated material or decorative fabrics.

3. Acoustical plasters, applied with a trowel.

4. Fibrous mixtures, applied with a spray gun.

The most popular of these for theatre use is the first named — rigid units or "tiles." This is chiefly due to the fact that the thickness, and therefore the property of absorption, is more easily controllable and uniform. A great variety of materials in this classification offers a wide selection in appearance, and the decorative possibilities in "tile" patterns are many. Some truly amazing effects have been obtained with the use of a little imagination and artistic sense, as the illustrations presented herein will well bear out. Certain types of tiles, characterized by small surface perforations, can be painted repeatedly without injury to the acoustical properties.

Flexible felts and blankets, as previously mentioned, require a covering. This cover-

ing may be of any porous fabric or perforated material. Perforated metal or fibreboard provides substantial protection and permits of painted decoration.

Acoustical plasters and sprayed-on mixtures depend largely on the skill of the applicator for proper mix, uniformity of thickness and result. They are especially advantageous for use on sharply curved surfaces, inasmuch as they offer a "one-piece" rather than a tile pattern treatment. Their use is generally confined to new construction. Care must be taken in painting and decorating in order not to destroy surface porosity and thereby injure the acoustical properties.

Highly decorative panels of perforated acoustic tile on ceiling of a church auditorium.

Effect of Sound Frequencies

While all acoustical materials have the common characteristic of absorbing sound, they differ widely in effectiveness at different pitches or frequencies of sound. Although materials are rated for their effectiveness at the frequency of 512 cycles, and at the average for several frequencies (noise reduction coefficient), complete test data is available and is considered by the acoustical engineer in planning a theatre correction. Extreme care must be taken in the selection of materials, as some

are deficient in absorbent qualities at the low frequencies.

How much acoustical material does a theatre need, and on what surfaces should it be placed?

These questions can be answered in each individual case by a scientific analysis, and without guess work. The acoustical engineer, in determining the answers, uses accumulated and available tables of sound-absorption coeffcients, the Sabine and Eyring formulae, tables of ideal reverberation times for auditoriums, and such practical considerations as the relative availability and economy of applying material on different walls or ceiling surfaces.

The principal manufacturers of acoustical materials offer free engineering service to assure the correct and satisfactory use of their materials. They also provide experienced and responsible applicator service.

The sale of the theatre's sole product—entertainment—depends on the patron's ability to see and to *hear*. The cost of providing good acoustics is small when compared with the total cost of building and furnishing the theatre. It is regrettable that it is too often passed up in favor of other items which may be more "showy," but which are far less potent as inducements to patrons to return. Surely a *good* job, correctly engineered and installed, will pay dividends in the long run.

"So you want a job in this theatre. Tell me, do you drink?"
"Sure, thanks, but let's talk about the job first."

Theatre Acoustics

And the Value of Acoustical Materials

By J. B. SHUMWAY

Acoustical Engineer, The Celotex Corporation

Too many theatre owners and operators fail to appreciate the full value of providing effortless hearing for their patrons. Many owners do not realize that they have poor sound conditions, due to a faulty sound system, which can be corrected only by repairs or the installation of new equipment. And many do not realize that frequently poor sound conditions, rendering the program harsh and nearly unintelligible, are due solely to the acoustical weaknesses of their theatre. The patron who has experienced good acoustical conditions will fully appreciate the value of sound conditioning. There is no substitute for easy, comfortable hearing. Where it exists, new patrons become regulars. The best picture, the best possible projection, and the lowest box office cost can be entirely nullified in the mind of the relaxation-seeking public by blatant noise which makes dialogue unintelligible. Frequently this disturbing noise is due entirely to excessive reverberation. People come to your theatre for entertainment, relaxation and recreation. To keep them coming, your facilities must parallel in attractiveness, comfort, and technical excellence the outstanding quality of the programs you are purchasing.

Poor sound often results from poor acoustical conditions. Sound which strikes highly reflective surfaces, such as floors, plastered walls and ceilings, rebounds with almost undiminished energy and remains within the room, reflecting from surface to surface, for a considerable period. Almost immediately every part of the room is filled with reflected sound waves traveling in every possible direction which cause reverberation or prolongation of the original sound. Excessive reverberation is particularly disastrous to the clear understanding of speech. If at the moment the speaker is uttering one syllable, the sound of the preceding three or four syllables is still audible in the room, the overlapping and confusion of successive words and syllables makes all of them "blurred" and "fuzzy". Many theatres, due to their shapes and sizes, have major acoustical defects which cause echoes and objectionable concentrations by a focusing of the reflected sound. Curved surfaces which cause focusing can, in most cases, be broken up to remove any focusing effect.

In most cases, theatres that suffer from undesirable sound conditions can obtain satisfactory correction by the proper installation of suitable acoustical materials. Many theatres have secured satisfactory results by treating the ceiling area and the back wall. Where possible, it is usually advantageous to place the treatment on side and back walls. Under any conditions, if a theatre is over fifty feet in length, it is essential that the back wall be treated. Usually it

should be loaded as heavily as possible with a material having a high absorption coefficient in order to eliminate any echo or backslap in the seating area. In most instances it is also essential that the wall area behind the screen opening be covered with an acoustical material.

is one of the major reasons why perforated acoustical materials are more widely used than other types.

Perforated materials are not dependent upon a porous surface for absorption. The sound enters the body of the tile through the mechanically made "holes". The surface area between the holes is not absorbent, hence paint here does no harm—and the perforations are of such size that normal painting and decorating procedures will not clog them.

An interesting combination of ceiling and side wall panel treatment.

Factors in Acoustical Materials

Several factors govern the selection of proper acoustical materials for a given theatre. First, of course, is the matter of adequate—but not too much—sound absorption. Secondly, is it flexible enough to work into the decorative scheme? Third, and most important from the standpoint of permanency, can it be easily redecorated without loss in efficiency? This last factor

Celotex makes two types of acoustical materials—one of cane fibre, and another of mineral fibre, the latter admitted in all construction where non-combustible materials are required.

The most distinguishing characteristics of a Celotex acoustical product are its perforations. These perforations are of definite diameter, depth and spacing.

Perforations

All acoustical materials are porous. The sound impulses enter the maze of tiny spaces in the body either through the natural interstices on the surface or through mechanical perforations made in the face of the material expressly for the admission of those sound waves.

In penetrating and traveling through this maze, the sound wave encounters just enough resistance to create friction which transforms the acoustic energy into heat.

Practically, the sound is "soaked up" by the material rather than reflected back into the room.

The cane fibre materials are made of tough cane fibres called bagasse. In the minute interstices between the fibres, sound is dissipated by friction.

Acoustical efficiency may be obtained in combination with modern interiors, as is shown in this application of perforated tile in the Ambassador Theatre, Baltimore, Maryland.

The most important technical advantages of bagasse fibre are purity, resistance to decay, length, strength, springiness, bulk, and the sawtooth character of the fibre. Owing to the deficiency in nitrogen and mineral salts, the bagasse is much more resistant

to decay than other vegetable fibres.

The cane fibres used are thoroughly coated during the manufacturing process with chemicals that make them water resistant. The practical value of this treatment has been demonstrated in thousands of installations in all parts of the world. Only in rooms where conditions of excessive humidity exist for long periods is this product not recommended.

Fire Resistance of Cane Fibres

While it is not claimed that the cane fibre material is "fireproof," it does stand up well in actual service, and in several respects may act as a fire retardant.

1. It does not flame readily as does wood, because it does not contain pitches or resins, which, under the influence of the temperature of combustion, may generate inflammable gases that accelerate the fire to the point where explosions result. These tiles burn or smolder at a very slow rate.

2. As this material has a high heat insulating value, it retards the passage of the heat of the fire to combustible matter beyond. There is, therefore, a tendency to confine the fire to the room in which it originates and to hold the fire until proper steps can be taken to put it out.

3. It is usually applied against a solid incombustible backing without open joints or cracks through which a flame can pass and ignite inflammable material beyond.

Mineral Fibre Materials

Acoustical materials made of mineral fibres (rockwool) are felted in a manner similar to that used in the manufacture of cane fibre materials, but with the addition of a suitable binder. This binder is added to provide strength and toughness in the finished product.

Sound is dissipated by friction in the minute interstices between the fibres.

The tile is integrally waterproofed during manufacture by means of a chemical treatment which prevents disintegration where the tile is accidentally submerged in water. However, it is not recommended for use in rooms where conditions of continual excessive humidity exist.

Mineral fibre materials are rated as incombustible.

Engineering Aid Required

Each individual theatre, because of its physical dimensions and characteristics, presents a separate problem in acoustical treatment. Although the customary treatment of covering back and side walls is ordinarily satisfactory, there may be special factors, such as balconies, unusual ceiling heights, extensive draperies or other conditions which require special tailoring to solve the problem and to provide a pleasing and artistic appearance.

The major manufacturers of acoustical materials are usually represented by a nation-wide distributor organization, each of whom maintain a trained staff of acoustical engineers to properly service their customers' requirements. Since each installation of acoustical correction presents an individual problem, the wise theatre owner will consult a reputable acoustical distributor and obtain engineering assistance which is furnished without obligation. The Celotex Corporation annually holds an Acoustical School for the personnel of its distributors' organizations to train men in the technique of acoustical analyzation and installation and to familiarize them with the solutions of the engineering problems involved. This school is designed for the initial training of men new to the acoustical business and as a refresher course for the experienced men who wish to familiarize themselves with the latest developments in the industry.

The Projection Room

No discussion of theatre sound conditioning would be complete without a word about the projection room. Two problems arise here; first, the simple matter of machine noise that may escape through the ports into the audience area. This is par-

ticularly objectionable where the projection room opens immediately onto the balcony. Substantial reduction of this noise can be effected by treating the ceiling of the room with acoustical material. Even more important is the necessity of improving the hearing conditions within the projection room where the monitor horn is located. No projectionist can be expected to handle the sound control in the auditorium properly when the reproduction from his monitor horn is masked by machine noise.

Another item of "customer-comfort" that should have attention is the attractive restfulness of the foyer areas and the luxurious quietness of the rest and smoking room. These areas, when designed and decorated for your patrons' comfort, can do as much as anything toward convincing them of the exhibitor's interest in their pleasure. Acoustical treatment of foyer areas will provide comfortable relaxing waiting space, as well as preventing objectionable and distracting noise from entering into the auditorium proper. Nothing can be more annoying than external noise interrupting a

Under balcony decorative application of acoustical material, showing border design and ceiling treatment.

fascinating program. The impression of luxuriousness created by handsome furnishings complimented with acoustical quietness in rest and smoking rooms is an asset that will bring you new customers and will make them "regular" patrons.

"Mr. Heft, my wife and I are finding it difficult to live on my salary."
"That's too bad, Jones. Why don't you see a lawyer and get a divorce?"

Acoustical Problems

Treatment for Better Theatre Sound

By ALLEN WILSON
The Celotex Corporation

Since the introduction of the sound track to motion pictures, valuable experience has been gained in achieving satisfactory acoustical conditions in theatres.

The acoustical problem presented by the modern amplification system is entirely different from that encountered when dealing with the unamplified human voice or musical instruments.

With unamplified sound, a substantial amount of reverberation is desirable to reinforce the original source. However, with modern electrical reproduction systems, all necessary reinforcement is amply taken care of by the sound system. It is of primary importance in a theatre to preserve the illusion that the sound is coming actually from the scene being portrayed

An artistic employment of acoustical tile on side walls—the Nile Theatre, Minneapolis, Minnesota

instead of from loud speakers behind a screen. To heighten this illusion it is necessary to reduce "reverberation," "flutter," "back-slap," and other "room" effects to the point where they cause no distraction. In other words, the audience must be allowed to forget that they are in a theatre, acoustically speaking.

possible; if not, it should be "loaded" with treatment to a point where it is almost wholly sound absorbent. No absorbent is placed on the ceiling unless it is unusually high. Adequate treatment is placed on the front wall behind the screen and speakers to prevent back-slap through the screen opening.

The acoustical treatment of auditorium side walls, flat rear wall, and the area beneath the balcony (Riviera Theatre, St. Paul, Minnesota)

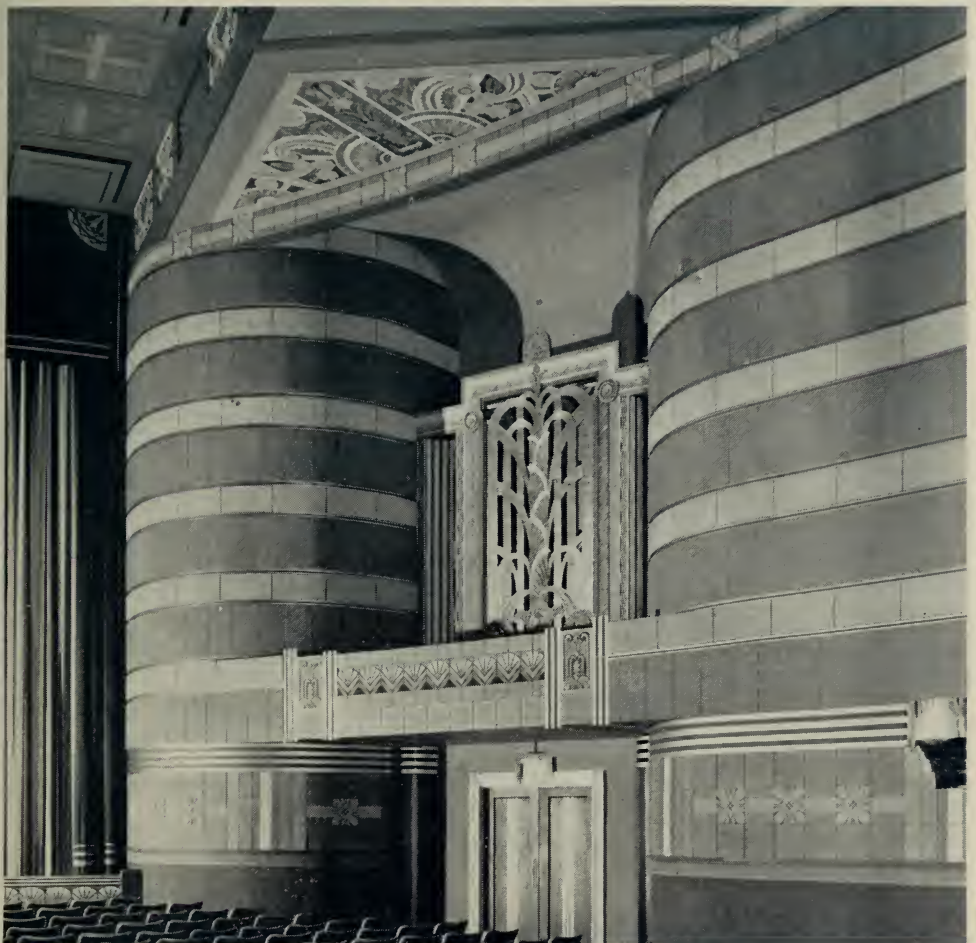
While each motion picture house presents its own problem, the experience of sound conditioning engineers indicates a general formula for acoustical treatment in an average house. This basic plan provides for an equal amount of acoustical material on each side wall, distributed from ceiling to wainscot line, and from the rear wall to within 20 or 30 feet of the proscenium arch. The rear wall should be broken into non-continuous surfaces if

Side Walls

Experience has shown that in the 1,000-seat auditorium of average design, approximately 600 square feet of acoustical material, with .50 to .60 noise reduction coefficient, are required for each sidewall, (the number of absorption units are calculated in relation to the absorption of the seats and carpeting).

In allocating the recommended amount of treatment, the decorator is permitted

to arrange it in almost any design he chooses within the prescribed area. To work out the design he may be allowed a leeway of 50 square feet over or under the

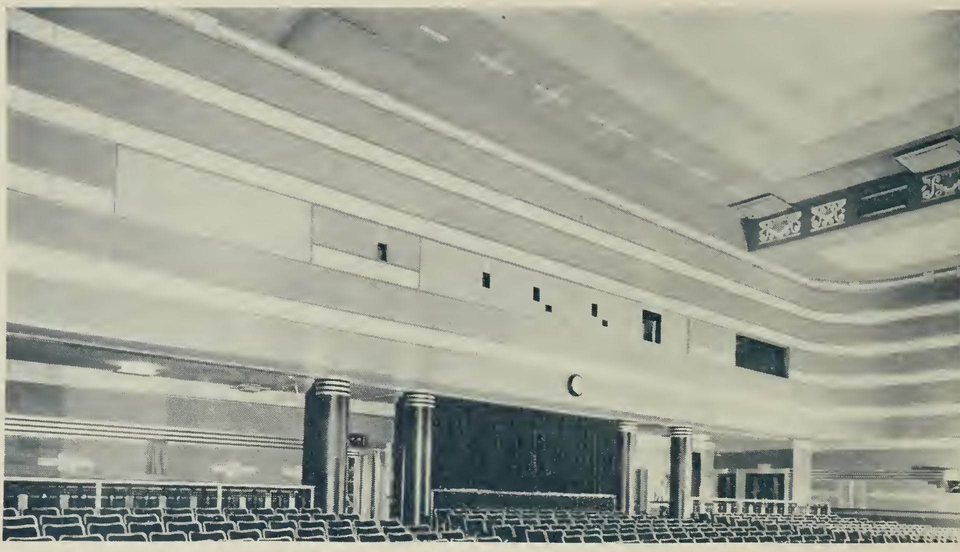


Curved surfaces on side walls and a high ceiling requiring acoustical treatment

600 square feet and the only limitation is that he should not leave large panels of hard wall surface directly opposite each other across the room. Such surfaces will likely cause cross-reflection, or "flutter". It is desirable to bring the treated area down to a line about 5½ feet from the floor.

Rear Wall

If the rear wall of the average auditorium is broken up, it usually requires about 300 square feet of material, with a coefficient of .80 to .98. If it has to remain flat and unbroken, it is completely covered from the ceiling down to a line about four inches above the head height of those seated in the back row.



Acoustical installation along the rear wall of the Ambassador Theatre, Baltimore, Maryland

Where curved back walls are encountered, it is recommended that the curve be adjusted so that the center of the radius of the arc will fall well back of the speakers and the screen. A smaller curve is sure to focus annoying echoes somewhere in the audience area.

Area Beneath the Balcony

Areas underneath balconies are considered as separate rooms. In most instances only the back wall is treated, no treatment being given the underside of the balcony, which really constitutes the ceiling of this "room".

Ceilings

In theatres without balconies, or with small, flat balconies, ceilings are low enough that they furnish useful reflection of sound from the screen and thereby help to maintain more uniform loudness from front to back of the seating area. Low ceilings should therefore be left untreated. Where a non-acoustical fibre board has been used for ceiling finish, it may be painted to increase its reflectivity.

Ceiling heights of more than about 25 feet in the front of the room tend to produce delayed reflections and reverberation, particularly of the bass tones from the comparatively non-directional low frequency speakers. High ceilings should consequently be acoustically treated, at least in the front portions.

Front Wall

A blanket of a material similar to Ozite carpet lining, the size of the screen opening and hung loosely against the wall, is effective in eliminating back-slap from a wall behind the horns. This treatment absorbs the "standing wave" that is sometimes set up between the horns and the wall, and also kills reflections from the rear wall to the front. Rock wool, supported by wire netting, has been used, but when this is employed, a dark covering should be placed in front of it to prevent light reflection from getting back into this

space through the screen.

Installation of Acoustical Material

To obtain as nearly as possible a straight line absorption across all frequencies, the acoustical material is applied on furring strips. The diaphragmatic action of such mounting on furring strips goes far in absorbing those low tones between 60 and 300 cycles that are largely responsible for a "boomy" house. It was their original efforts to eliminate this booming which convinced engineers that the most satisfactory reverberation time for the majority of houses is one slightly on the dead side as compared with optimum times for general use auditoriums. This does not mean that any tendency toward "deadness" is sought, but rather that a little less reverberation is allowed than for an auditorium in which the sound of the performance is not electrically amplified.

Projection Room

There are two important reasons for acoustical treatment of the projection room. First, there is the machine noise that escapes into the audience area through the ports. This is particularly objectionable where the projection room opens immediately into the balcony. Even more important than reduction of the noise escaping into the auditorium are improved hearing conditions within the projection room, where the monitor horn is located. No projectionist can be expected to handle properly the sound in the auditorium when the reproduction from his monitor horn is masked by machine noise.

Substantial reduction of this noise can be effected by treating the ceiling of the projection room with an incombustible acoustical material.

Other Theatre Areas

Sound conditioning to suppress noise in foyers, lounges, and around refreshment booths is a problem that also needs attention in many theatres; however, since this is apart from acoustical correction in the auditorium, it will not be discussed here.

"So you're building nothing but open air theatres?"
"Sure, no overhead."

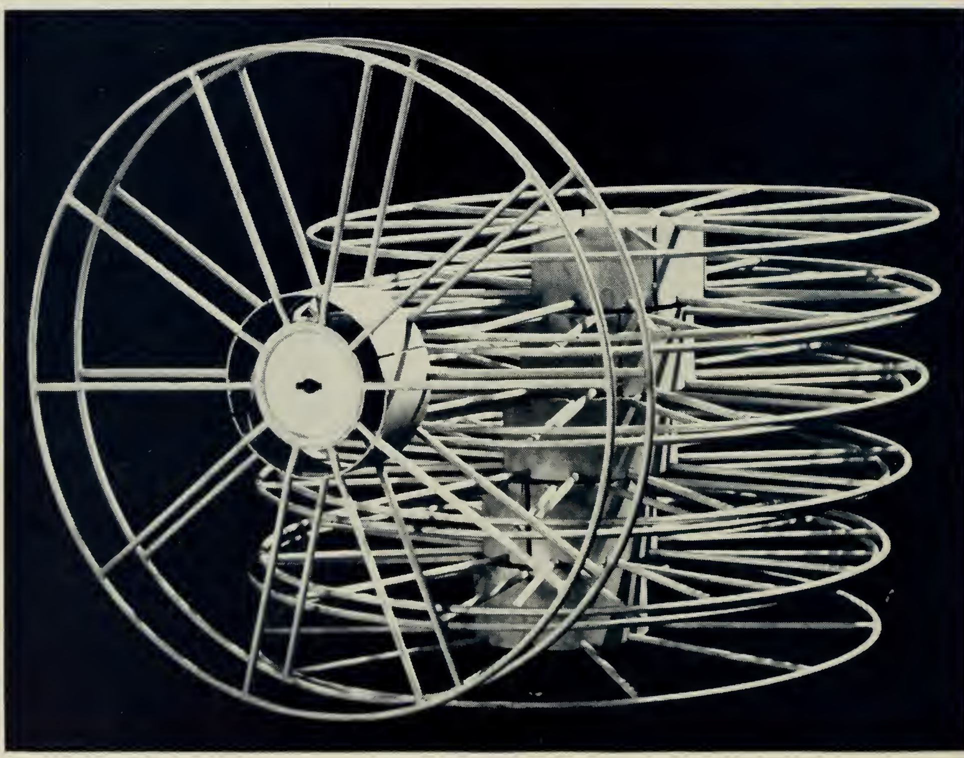
PROJECTION BOOTH SUPPLIES

Neumade Products

Items for the Projection Booth

By F. G. SLOAN

For a quarter of a century Neumade has been making a line of equipment for producers, distributors and exhibitors. Many of the rewinders, reels, projection booth tables, film storage cabinets, film cans, ticket boxes and spotlights used in 35



The wire welded reel.

mm. and 16 mm. motion picture applications are carrying the trade name Neumade.

Notable among the items produced by Neumade are wire welded and all-steel reels, a line of nine different types of rewinders, modern ticket boxes, and steel projection room film storage cabinets.

Neumade Everwear Rewinders

Rewinders and Reels

For over a quarter of a century Neumade Products Corporation has built one of the most complete lines of rewinders.

One of the features is the patented reel-locking jack which prevents the reel from flying off the shaft.

The Neumade Everwear Rewinders, are heavily constructed with full reinforced channels and three-point base which prevents rocking.

The wire welded reel has gained wide popularity because of its rigidity, balance, non-corroding, non-rusting finish and the total absence of sharp edges or joints.

Film Cabinets

The Neumade "Firetite" film storage cabinet has been fully approved for use everywhere in the country. Built like a vault, with 1½-inch double wall construction of heavy gauge steel throughout, and

filled with the patented approved plastic heat and fire resisting compound and hard brick, it has been built to withstand the most severe fire. The doors, similarly constructed, are fitted to automatically shut and its double-walled construction is filled throughout with $1\frac{1}{2}$ inches of poured approved plastic fire-proofing compound, which, when dry, becomes brick-hard.

The automatic closing and three-point

"Firetite" film storage cabinet, showing fireproof construction.

tight and stay closed. These cabinets are available in units of 5, 6, 8, 10 and 12 two-thousand foot reels.

The "Fume-tite" film cabinet is approved by the Board of Standards and Appeals for use in New York City. It holds twelve 2000-foot reels in two tiers of six each, and has a quick fusing sprinkler head enclosed in heavy gauge wire mesh. It is equipped with an 8-inch x 10-inch vent self-locking door can swing from either side.

Other Equipment

One of Neumade's typical booth rewind tables with film cabinet in place on the rack is illustrated. These tables are rigidly built, entirely of steel, in a variety of styles and sizes. Racks and drawers for carbons,

Neumade booth rewind table with film cabinet in place.

tools, titles and seals are available. The three-inch block front top extension provides for clamp-on or bolt-on type rewinders.

Another item in the Neumade line is the scrap film can, with inner galvanized pails, and a step-on lever which lifts the cover. They are available in several sizes.

Scrap film can, showing inner galvanized pail.

The "Fume-tite" film cabinet, equipped with sprinkler head.

SCREENS

Screen Surfaces

Some Facts on Brightness and Distortion

By CHESTER COOLEY
President, Da-Lite Screen Co., Inc.

A clean bright picture, such as every theatre owner desires to bring before his patrons, requires a combination of projectors, arc lamps, rectifiers or generators, all in good condition—and a new screen.

Everyone conversant with motion pictures knows that the screen plays an appreciable part in improving picture definition, and I intend to go into the details of this subject more thoroughly a bit later. You will find that a new screen also makes for better sound. A sound screen, as we know, has holes in it so that the sound from the loud-speaker system located back of the screen may come through to the audience. These holes have a tendency to become clogged with dirt and grit, or plugged up with paint, all of which detracts from sound quality.

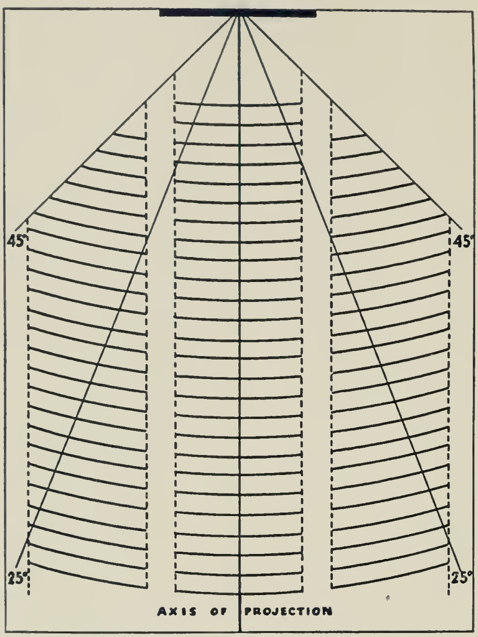
So that while buying a new screen is more important than ever today, buying the right kind of a screen is equally important. Don't just buy a screen—or don't pick your screen on price alone. Real economy lies in purchasing equipment that gives satisfaction and possesses wearing qualities. Look for fabrics that will stay white and pliable, or in a beaded screen, one in which the beads will not shatter off. And buy the one that best complements the projection angles and the equipment you have in your booth—whether it be a white, a silver or a beaded screen.

I have no intention of endeavoring to cover the whole subject of screen qualities in this one article. The primary function of a screen is to reflect and distribute the projected light so that it is neither lost nor diminished in value. This brings us to the subject of screen surfaces, which determine the lighting and brightness of the screen.

If all motion picture theatres were exactly the same, and if all projection equipment was equally efficient and possessed the same light capacity, it would be an easy matter to standardize on one type of screen surface. As a matter of fact, these conditions vary greatly. We therefore have three general types of screen surfaces—white, silver and glass beaded. All of these have certain reflective characteristics in common, but there are well defined conditions under which each will function more efficiently than any of the others. These conditions are based largely on whether high or low intensity arc lamps are employed, the length of the throw, and the projection angles and consequent degrees of brightness and distortion.

Screen Image Distortion

The House Plan illustrated herein affords a fairly accurate representation of the seating arrangement of most theatres. Two viewing areas are outlined on this drawing



A Typical House Plan

—one located between the angles of 25 and 45 degrees, the other area in dead center between the angles of 25 degrees. The seating area between the angles of 25 and 45 degrees is only about half that of the dead center area. No seats should be provided at angles greater than 45 degrees, as beyond this point distortion becomes excessive.

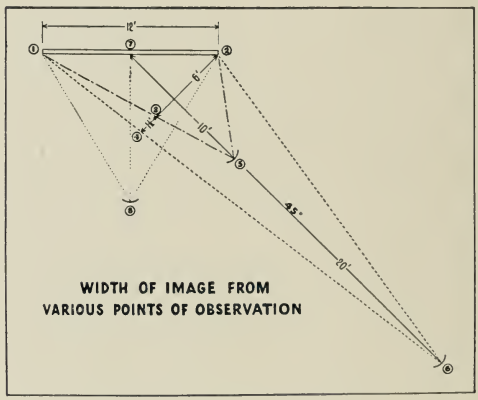
Let us glance now at the Distortion Chart. Screen image distortion, resulting in the elongation, foreshortening and tapering of the figures, involves three elements —the photography, projection and viewing angles. As the first two are largely governed by fixed conditions, we shall concern ourselves here with the viewing angle.

The entire width of a screen is not visible when viewed from severe angles, as demonstrated on this chart. The points shown by figures 1, 2, 3, 4 and 7 are guide marks to indicate varying conditions when a 12 foot screen is viewed from different angles and distances.

A person seated ten feet from the screen at the point indicated by figure 5 would view the projected picture from a 45 degree angle. The subjects shown on the screen would appear in the proportion of one-half the width, or the distance between points 2 and 3, so that an image actually measuring 2 feet wide by 5 feet high would appear to be only 1 foot wide by 5 feet high.

The distance between figures 2 and 4 represents the screen width as seen from a distance of 30 feet and an angle of 45 degrees (at the position indicated by figure 6), from which point a 12 foot screen appears to be 7½ feet wide.

Figure 8 represents a position directly in front of and on a center line with the screen. From this point the images appear in perfect proportion regardless of distance, and are therefore free from distortion.



Distortion Chart

It will thus be seen that distortion is a phenomenon of perspective, and that there is nothing the screen can do to control it. Distortion can be minimized only by an intelligent seating of the audience within permissible angles. I have mentioned the subject in some detail only because the viewing angle has an important bearing on the relative brightness of the various screen types, and must be given careful consider-

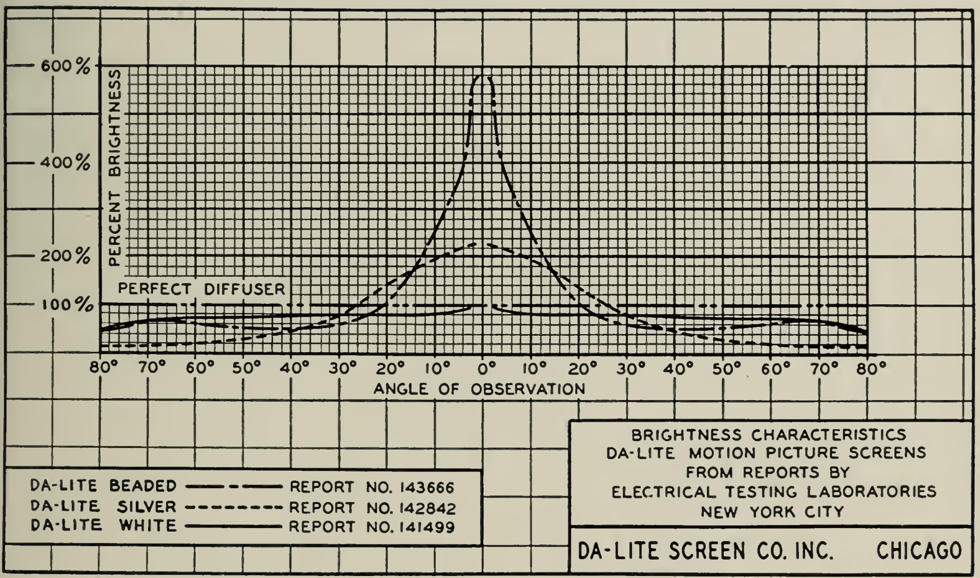
ation in choosing the right screen surface.

Relative Brightness of Surfaces

The comparative brightness and diffusive characteristics of the white, silver and beaded screens may easily be determined by reference to the chart showing Brightness Characteristics.

perfect diffuser is indicated on the left of the chart.

It will be noted that when viewed from dead center, the beaded screen is more than five times and the silver screen more than twice as bright as either the white screen or the perfect diffuser. The theatre owner may check the relative brightness of the



Brightness Characteristics

The bottom row of figures on this chart represents viewing angles from 1 to 80 degrees, although, as previously mentioned, the distortion becomes excessive beyond 45 degrees and the question of screen brightness accordingly loses much of its importance. The white screen, however, is slightly brighter than other types when viewed from excessive angles.

The straight horizontal line marked "Perfect Diffuser" designates a screen surface capable of reflecting and distributing projected light uniformly to all angles from the projection axis. The percent brightness of the various types of screens when viewed from different angles as compared to the

three types of screens for his own particular house by taking readings on this chart at various points from dead center up to the actual maximum viewing angle involved.

We will perhaps obtain a better idea of this whole subject of screen surfaces if we consider each type of screen separately, both from the standpoints of brightness characteristics and type of lighting employed.

The White Screen

The mat white screen has for many years been the type most commonly used in the theatre field. It is especially suitable, for reasons to be explained, in larger theatres where carbon lamps ranging in capacity

from low intensity to high intensity produce a brilliant picture even on a white surface.

The white screen is unexcelled for diffusion of light. If we look at the Brightness Chart, we find that the brightness of the reflected light is maintained at almost unimpaired uniformity from the axis of projection up to an angle of 70 degrees. When viewed from all angles between 25 and 45 degrees, white screens average about 18 percent brighter than silver screens, and about 20 percent brighter than beaded screens. This makes them of particular value in large or very wide theatres, where a considerable portion of the audience must be seated at wide angles of observation.

Let us take as an example an extra wide theatre with three thousand or more seats. The distance from the projector to the screen is 144 feet, while many of the seats are located at angles of 30 degrees or more from the center. The picture size is 18 feet by 24 feet, or an area of 432 square feet. A white diffusive screen would be recommended for this type of theatre due to the extreme observation angles, as the picture brightness from the 25 degree angle over to 60 degrees would thereby be improved.

While the white screen is a splendid diffuser, it absorbs some light and is therefore considered a poor reflector, even on the line of projection. Again referring to the Brightness Chart, it will be noted that the percentage of brightness reaches 100 at no point. This low intensity of reflection of the white screen may be safely discounted, however, when the projection equipment is capable of delivering a sufficient amount of light to counterbalance the decreased reflective properties. As all large theatres with wide angles of observation have an abundance of projection light from high intensity or low intensity carbon lamps, the two most favorable factors for the use of the white screen would be present.

The Silver Screen

When we speak of a silver screen, we are really talking about a wide variety of screens that differ greatly with each individual make. They range in values from a dull surface scarcely brighter than a white screen to a mirror-like polished surface entirely unsuitable for projection purposes in all but a limited field. It therefore becomes impossible to talk about silver screens as a class, as the actual reflective values of each type must be considered separately.

Our own Da-Lite silver screen may be described as semi-diffusive, and is designed for theatres having viewing angles not exceeding 40 degrees, either with or without balconies. When viewed from the center of the screen, the picture on the silver surface will be more than twice as brilliant as it would be on a white screen if shown with the same illumination.

The silver screen has one disadvantage which does not exist with either the white or the beaded screen. It must be stretched smoothly, or the slightest wave or irregularity in the surface will show in the projected picture. The same thing applies to seams, which show up as dark lines wherever they appear. The only way to avoid lines in a silver screen is to buy a screen with seamless construction and thus avoid the seams that cause them.

The Beaded Screen

The Da-Lite beaded screen consists of an especially developed pure white fabric, upon which has been superimposed a single layer of minute glass beads, each about eleven one thousandths of an inch in diameter. The beaded surface will remain pliable, and the beads are guaranteed not to shatter off.

Beaded screens are especially suited to smaller theatres, in which the observation angle rarely exceeds 25 or 30 degrees. In such a theatre the operating cost of high intensity arc lamps may be prohibitive, while if low intensity or Mazda lights were used with a white screen, the picture brightness would be less than the standard 10 to 15 foot candle light requirements. The

Interior of Capitol Theatre, Chicago—a wide theatre, indicating the use of a white screen.

logical alternative would be the employment of the more highly reflective beaded screen, thereby obtaining sufficient brightness and diffusion without additional operating cost. The very few persons who may be seated outside a 25 degree angle would have a picture almost as brilliant as that produced on the white screen, while for the majority of the audience it would be several times brighter.

The beaded screen is neutral in character, and suitable for both color or black and white pictures. It is, in fact, ideal for color pictures because of its greater brilliance, as colored films have increased density and consequent reduced illumination.

I have thus endeavored to outline both the advantages and disadvantages of all types of screens in use today. Much of what I have said is no doubt already familiar to the experienced theatre man. If he finds some piece of information, however, that will enable him to make a wiser selection of his new screen—if he only learns the all important rule of selecting a screen to conform to his theatre and his projection equipment—then I shall be very pleased indeed.

Sound and the Screen

Proper Perforations Aid Transmission

By CHESTER COOLEY

When we think of sound in relation to the screen we think of "holes"—or the perforations which make transmission possible.

There is nothing so very startling about these holes—just a piece of air with some sound screen wrapped around them, as a matter of fact. Yet, believe it or not, when sound pictures were introduced, the question of getting sound through the screen presented a major problem.

In the old days of the silent pictures, we had no worries about holes and sound transmission. The first screens used in the theatre were nothing but plastered walls or whitewashed sheets, which absorbed so much of the feeble light available from our early projectors that the theatre had to be kept pitch dark. As time went on, screens improved in corresponding relation with other theatre equipment, and everything was lovely—until along came sound.

It soon became apparent that sound wasn't going to be of much good to anyone unless some method were found of getting the sound from behind the screen so that the audience might hear it. The first device that was hit upon will make you wonder why Thomas Edison didn't stop right then and there and turn over his job to Rube Goldberg.

I do not know the name of the unhonored and unsung genius who invented the "B.V.D." screen. I call it that (although perhaps the inventor did not) because it was made of that sort of cheesecloth material from which we fashioned our B.V.D.'s, when such raiment was in fashion. Well, the sound came through that screen but the projected picture brought back fond recollections of those tin projectors we used to buy for little Johnnie in the bargain basement for $2.98. Unless you could follow the thread of the story from the dialogue you were just out of luck, because the picture was about as clear as Einstein's theory of relativity.

The Perforated Screen

And so the lowly hole assumed a place of honor in the theatre. By simply perforating screens with round holes properly spaced we were able to bring the sound through the screen without seriously disturbing light reflection and distribution.

I suppose most of you have heard the story about the theatre owner (I believe he lived in Oklahoma, although maybe that is because Edna Ferber says that almost everything has happened in Oklahoma), who solved the problem of converting his silent screen into a sound screen by blasting holes in it with a shotgun. But don't you believe it, because the proper perforating of a screen is based on scientific principles. If it weren't, we could just sit back, and let the moths do the work.

The perforation of a sound screen consists in providing evenly spaced minute holes of the proper size and number to allow for the free flow of sound from the speakers located in the rear of the screen,

without reducing its reflective capacity below standard requirements (this definition is not by Webster, but by Cooley). The best results can of course be expected only when the projected light is adequate for the size and type of screen being used. The holes, in addition to being properly spaced, must be of the correct size, in order to provide a proper balance between transmission of sound and reflective capacity.

compromise between sound requirements and the screen's reflective properties. When made correctly, the screen should give good picture presentation without unduly muffling the sound.

Sound transmission in a new perforated screen is affected by two factors—the thickness of the finished screen and the size and number of the perforations. Both of these factors in a screen are controlled at the time of manufacture.

Section of sound screen, showing proper relation between perforations and screen area.

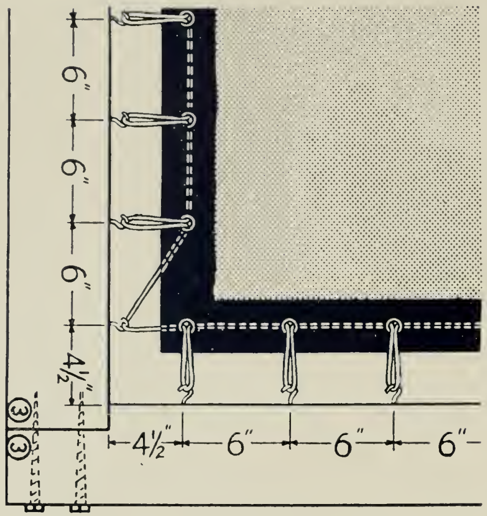
Importance of Screen

Now, there is another phase of this problem that we should consider, and that is sound transmission. Very often this all important factor is not traced to the screen when the sound goes sour.

The manufacturers and laboratories who pioneered sound reproduction established sound standards long ago through scientific methods. In accordance with these standards, a properly made screen should have clean-cut, regularly spaced holes of the proper size and number. This percentage of open area is constant, and represents a

The screen may not be as complicated or as interesting as some other pieces of theatre equipment, but after all, neither are all of our movies of the blood and thunder variety. What does matter is that screens are far more important than many exhibitors realize. Since sound and its proper transmission is just as important as the picture itself, the screen must play a considerable part in keeping both sound and picture brightness on an equal par.

Let us now pass on to the question of the possible effect on the sound after the



Corner section of sound screen

screen has been in service for a long period of time, or when it has been recoated.

In most installations, there is a circulation of air through a sound screen, and this air is bound to carry with it some dust. This dust will in time impair the screen's sound transmission properties by partially closing the holes. When a screen is recoated, you add to the thickness of the screen, while at the same time closing a substantial percentage of the open area. This will muffle the sound—especially so at the higher frequencies.

I realize that the average theatre owner wants to use his equipment just as long as he possibly can, and I have no quarrel with him for it, for I am just as much a believer in true economy as the next fellow. Note that I say true economy. When your screen sprouts a thick crop of fuzz, it's high time to contact your theatre equipment dealer and get a new one.

New screens don't cost a lot of money. They represent one thing you can do to improve your picture and your sound. If you persist in using an old screen that is gone beyond redemption, you will have dark pictures, poor muffled sound—and less patrons at the boxoffice. That is not what I think of as true economy.

How to Order Your New Screen

By LAUREL E. COOLEY

Every exhibitor at some time or other is confronted with the problem of ascertaining the proper picture area suitable for his particular theatre. While most veteran exhibitors are well acquainted with all factors involved in making the proper selection of the reflective surface suitable for their particular house and equipment, there still appears to be some confusion in arriving at the correct picture area needed and the actual overall screen size. In some instances the exhibitors will find it necessary to make certain compromises to overcome various obstacles, such as the design and construction of the particular house in which the screen is to be installed, the distance from the screen to the first row of seats, and the source of light.

The picture area should never be larger than is necessary to permit needed screen brightness, and to relieve eye strain when viewing the picture from front row seats because of excessive screen magnification. Neither should the picture surface be smaller than required. Other factors to keep in mind which have a direct bearing

on your picture size are the source of light, focal length of lens, distance of light throw and the seating arrangement.

Figuring the Picture Size

In houses where the actual picture area cannot be measured by projecting light on the old screen, it would be good practice to figure the width of the screen as equal to at least one-sixth of the distance from the screen to the back row of seats. This would give you the approximate picture size desirable for comfortable viewing. In exceptional cases this rule cannot always be followed, because of excessive magnification for those sitting in the front rows, and where mazda lamps are used, this ratio may reduce the screen brilliance below standard requirements. In this event it would be more advisable to reduce the screen size slightly below the ratio of one-sixth of the projection throw.

Lens manufacturers usually supply a chart which will indicate the picture size at a given distance of the light throw with various focal length lenses.

When the charts are used for selecting the proper screen size in a new house or for a location where it is impracticable to figure the needed picture size from the old screen, it would be advisable to add six inches in screen width to the dimensions given on the chart. This will give you a margin of safety, and the picture area can be masked to proper size.

Screen Dimensions

In theatres where the stage or other openings limit the size of the screen and frame, the following instructions should be carefully considered. In locations where space permits, the frame should be 12 inches larger on the inside than the overall measurements of the screen itself. This will allow six inches between each edge of the screen and the frame, which is the space required to permit proper lacing of the screen to the inside of the frame. If a larger picture area is desired than can be obtained in this manner, we would then suggest that the screen be placed on the front of the frame. In following this procedure, the inside frame dimensions can be reduced to measure six inches larger than the overall screen size. When figuring the picture area, it should be remembered that the overall measurements of the screen will be five inches larger each way than the actual picture area desired, because of the 2½ inches which are necessary to accommodate the webbing and the grommets on each edge of screen. Example: To obtain a 12′ by 16′ picture size, it would be necessary to purchase a screen measuring 12′5″ by 16′5″ overall.

Any problems which you may encounter pertaining to stretcher type frame screens will receive prompt attention if you will contact your regular theatre supply dealer.

In requesting information from your supplier relative to the proper type and size of screen suitable for your particular house, always give the following information, which will be of considerable help in solving your immediate needs.

1. Type of light source.
   (a) Hi-Lo
   (b) Suprex AC or DC
   (c) High intensity
   (d) Low intensity
   (e) Mazda
2. Lens size.
3. Distance of light throw from projector to screen.
4. Distance from the screen to the back row of seats.
5. Distance from the screen to the front row of seats.
6. Approximate width and depth of seating arrangement.
7. The maximum viewing angle to accommodate the majority of seats.
8. Seating capacity.
9. Type of frame now in use.
10. Inside measurements of frame.
11. Location of speakers.

PROJECTION

Maximum Screen Illumination

How It May Be Obtained

By FRED C. MATTHEWS

The objective of manufacturers of projection room equipment for many years has been to give the theatre patron a bright, clearly defined picture with a minimum of flicker and absence of travel ghost.

All manufacturers of carbons, arc lamps, lenses, sound screens, and projectors have constantly improved their products. While individually each manufacturer has been successful in improving his product (some more than others), the fact remains today that the majority of theatres do not have maximum screen illumination.

Often the reason for poor screen illumination lies in the incorrect combination of individually excellent equipment. Sometimes it is the result of the use of some modern equipment with obsolete equipment, or it might be the result of incorrect adjustment of one or more of the items installed.

The above paragraph points out two important factors that the exhibitor must take into consideration if he is to obtain maximum screen illumination—one, the necessity for selection of a combination of equipment best suited to the particular needs of the theatre in which it is to be installed, and the other for consistently excellent maintenance of the equipment so installed. If the correct selection of equipment is made, and if the proper maintenance is given, the entire combination will continue to give maximum illumination.

It is not possible to give a blanket endorsement to any particular group of associated equipment, for what might be an excellent group of theatre equipment for one house might be inadequate for another. Therefore, when an exhibitor selects his equipment, he should utilize the full knowledge of the theatre equipment dealer and his own projectionist. The dealer keeps abreast of all new developments in projection room equipment so that he may intelligently advise the exhibitor, and the average projectionist has an excellent knowledge of the equipment he has run. Each day, too, he is becoming more familiar with equipment as he becomes an ardent follower of matters dealing with proper projection.

Importance of the Screen

An important part of good screen illumination is the sound screen itself. It is impossible for all theatre owners to standardize upon one type of screen as long as there is a variance in the size of theatres and a variance in the amount of illumination reaching their screens. For this reason,

most screen manufacturers offer screens with three different surfaces—white, silver and beaded.

The white screen has for many years been the type most commonly used in the theatre field, being especially suitable for large theatres where high intensity arc lamps are employed. Beaded screens are especially suited to smaller theatres where the observation angle rarely exceeds 25 degrees and where high intensity projection arc lamps are not employed. Silver screens may best be used in the smaller theatres where observation angles extend up to 40 degrees. Beaded and silver screens reflect more of the incident light than white screens, but cannot be used satisfactorily except in narrow houses because of the extreme distortion when they are viewed from side seats. Because of their greater reflectivity, they give a somewhat brighter picture and hence have some value where low intensity lamps producing insufficient illumination are still in use. The size of the screen to be installed depends upon the amount of illumination offered by the arc lamps selected. Theatres using One K W arc lamps or equivalent, should not install a screen over 20 to 22 feet in width. If installation of a screen of 22 feet or more in width is desired, then it is necessary to also install high intensity arc lamps.

Function of the Lens

Too often, when re-equipping a projection room, the exhibitor buys a new sound system, new projectors and new arc lamps, and yet continues to go along with his old projection lenses. The projection lens of ten year ago falls far short of equaling the quality of those of present day manufacture; consequently, old lenses are incapable of performing their valuable function of putting maximum light on the screen. Research has constantly made available better lenses operating at faster speeds, and present day lenses, particularly those of the anti-reflection coated variety, add much to good screen illumination. It is most important that the lens holder of the projector be designed to properly support these new larger lenses so that perfect optical alignment of all associated equipment may prevail.

Carbons

National Carbon Company has perhaps conducted more research on the subject of light than any other company in the theatre equipment and supply field, and now that the materials used to manufacture carbons are in better supply, today's projector carbons are as fine as research, men and machinery can make them. It is important, however, that the carbons employed be in correct relation to the amount of amperage utilized by the arc lamps.

The Arc Lamp

There are four types of arc lamps in use today:

1. The condenser type high intensity
2. The reflector type high intensity
3. The One K.W. high intensity
4. The low intensity

With the exception of the low intensity type, all of these types are modern and each is suitable for the particular purpose for which it is designed.

Low intensity arc lamps are still manufactured, though they have been outmoded by the various types of high intensity lamps. They are still made because they are the only lamps that can be safely used with the many obsolete front shutter projector mechanisms still in use. We merely mention low intensity lamps to stress again the importance of selecting the correct combination of equipment. Low intensity lamps are not recommended for modern projection service because they produce insufficient illumination, and because what they do produce is of the wrong color balance for good results with color films.

It is extremely important that the arc lamps employed be positioned so that the distance from the surface of the reflector to the picture aperture is in full accord with the distance recommended by the

manufacturer of the arc lamp. If the spacing is incorrect, the projected light will be poor and of a distinctly bluish cast. It follows of course in actual operation that the projectionist must maintain proper burning of the correct size of carbons.

It is important that the current supply for the arc lamps, a motor-generator set, or one of the several types of rectifiers, be of large enough capacity to supply the amount of power required. The arc lamps selected must of course be in proper relationship to the size of the theatre and its screen.

There is a distinct problem, however, when arc lamps utilizing over 70 amperes are used, and that is the probability of heat damage to the film. To quote an authority on arc lamps: "When new type Suprex carbons are burned at 70 amperes and projected through the modern f:2 coated lenses, our lamp will project 15,000 lumens of light with 60% light distribution as measured without the shutter. This is the maximum direct energy the film will accept without damage and is ample light to project a brilliant picture even on the tremendous screen used in a Drive-In Theatre."

The film can be damaged when high intensity arc lamps are operated at greater than 70 amperes unless a glass filter is located between lamp house and picture aperture. The use of various filters, however, (as reported in the Journal of the Society of Motion Picture Engineers, Vol. 45, No. 2, August, 1945), causes light losses up to 25 percent. There is thus little point in burning lamps at high amperages when filters are employed.

It is true of course that the greater the amperage the more the light produced. Under certain conditions, as in exceptionally large theatres and Drive-In theatres, lamps burning at high amperages may be employed if a blower is used to force air across the picture aperture and thus dissipate the excess heat.

The Projector Mechanism

All of the useful light which reaches the screen from the arc lamps must pass through the projector mechanism, but one of the functions of the shutter of the projector mechanism is to intermittently cut off the light from the screen, so that no matter how much light is produced by the arc lamps, all of it cannot possibly reach the screen all of the time.

The projector shutter alternately permits light to fall on one frame of the film for a fraction of a second and then blocks out the light for a fraction of a second, while the next picture is brought into place. The shutter is absolutely necessary, for without it the series of pictures on the film would contain numerous disconcerting streaks of light. The alternate light and dark periods permit each picture to stand out on the screen clearly.

It is therefore apparent that it is useless to select the lamps, lenses and screen best suited for the needs of a particular theatre unless one also selects a projector that permits the maximum amount of light emitted by the arc lamps to reach the screen when the shutter is open.

We have shown that a projector shutter is absolutely necessary, but what type of shutter should be looked for?

Mechanisms of old vintage, which employed a single front shutter mounted in front of the lens, definitely cannot be used with modern arc lamps because of the inability of such a shutter to prevent the heat from the light source constantly pouring into the aperture and on the film. This heat is so great that it will cause buckling of the film, and over a period of time, will warp the metal parts of the projectors.

Mechanisms employing a single-disc type shutter, mounted between light source and the aperture, are a marked improvement over those employing such a shutter located in front of the lens, as they partially prevent the heat from reaching the aperture and film. Such mechanisms, however, do not permit as much light to reach the screen as is desirable.

Four leading American manufacturers

producing projectors today urgently recommend their double shutter types over single shutter models. The reason for this recommendation is very simple—such projectors permit light to reach the screen for a longer period than will single shutter mechanisms.

High Intensity Arc Lamp

The single-disc type shutter has two blades of equal size, one of which (known as the master blade) cuts off the light from the screen during the period in which the intermittent movement is pulling the film into place at the aperture. The second blade (known as the balancing blade or flicker blade) is located at the opposite diameter from the master blade, and covers the aperture for a short period of time while the film is at rest, so as to double the light interruption frequency and thus make the flicker more nearly tolerable.

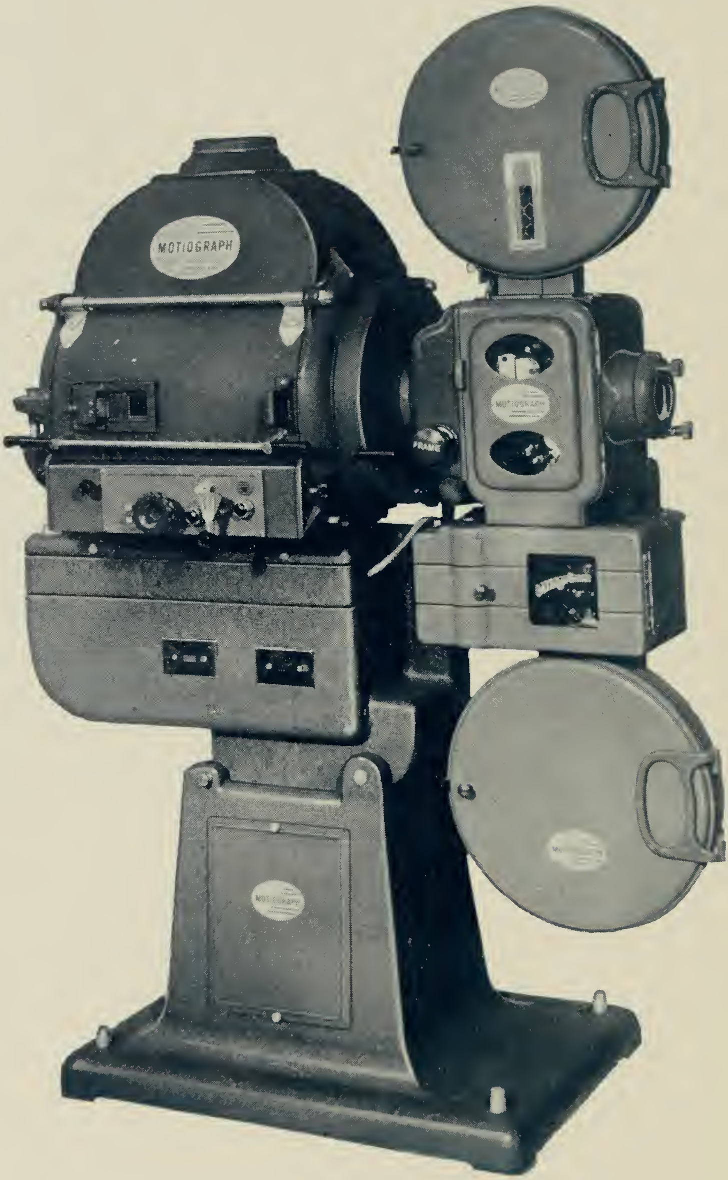
Double Shutter Mechanisms

When double shutter mechanisms are employed, the time to cut the light off the screen and restore it is reduced by one-half as compared with the single shutter, hence the screen receives a proportionately increased illumination.

It should be apparent from the above that best screen illumination can be accomplished by the combination of the correct arc lamps, correct screen, coated lenses and a double-shutter projector mechanism.

There still remain other factors affecting proper screen illumination which the equip-

ment dealer takes into consideration in recommending a particular double-shutter mechanism. One of these is the amount of flicker produced on the screen. Were it not for flicker and travel ghost, every manufacturer of double shutter mechanisms



A combination of modern equipment

would put very narrow blades on his shutters, as obviously the narrower the shutter blades, the longer the period of maximum light that can get through to the screen. Flicker is always present, no matter how much or how little light reaches the screen, for the screen illumination is not continuous and cannot be so in motion picture projection as we now know it. The magnitude of the undesirable effects it produces in the form of annoying eye strain is radically higher as the overall brightness of the picture increases, and this is the fundamental limiting factor on increasing screen brightness.

Some manufacturers of double shutter projectors have advertised that they give 20 per cent more light on the screen. As the amount of light must be in direct relationship to the amount of permissible flicker, the variance in screen illumination between all double shutter projectors is actually very small.

It would, however, be quite feasible in a theatre with a large screen, or in a drive-in theatre, to utilize shutters with very narrow shutter blades, as the ever present flicker becomes indiscernible when the light is spread out over a larger screen area. The use of such blades, however, would be undesirable on a small screen, as flicker would be clearly discernible. Motiograph has conducted actual operating tests in theatres of all sizes over the country to establish the correct blade proportions for optimum overall results in the different classes of theatres, and is in a position to provide projector mechanisms which will give the maximum possible screen illumination consistent with complete absence of flicker and travel ghost effects in all of the various classes of theatres.

In all of the foregoing discussion of flicker, it has been assumed that the current supply to the arc lamps is free from fluctuations. If such fluctuations are present, possibly due to defective or deteriorated rectifier tubes or copper oxide elements or to faulty commutation in motor generators, very serious flicker may be produced which is often erroneously blamed on the projector mechanism.

Recommended Equipment

To summarize—a small to medium sized theatre should have:

1. A screen less than 22 feet wide, with a surface suitable for the viewing angles in the theatre.
2. Arc lamps operating up to 50 amperes with a generator or rectifier capable of delivering such amperage without overload.
3. Anti-reflection coated lenses. (Very small theatres can use modern fast, uncoated lenses because of their small total light requirements.)
4. Double shutter projectors. If the screen is very small, the shutter blades should be of such width as to produce the maximum screen illumination consistent with freedom from excessive flicker.

A medium to large sized theatre should have:

1. A white screen larger than 22 feet. (Exact size to be determined by house proportions.)
2. High intensity arc lamps operating up to 70 amperes, and generator or rectifier of correct size. Exact amperage at which lamps are to operate should be determined by size of house.
3. Anti-reflection, coated lenses.
4. Double shutter projectors.

Large theatres and drive-in theatres should have identical equipment to the above, except that if high intensity arc lamps burning in excess of 70 amperes are used, the projectors should be equipped with the necessary blowers to prevent heat damage to the film.

Also Selected Short Subjects

By GRAY BARKER

Some time ago I visited a movie in my home town. The feature was P.R.C.'s production, "Corregidor," and I was looking forward to some light shorts to balance the war content of the former.

But instead, the first thing they gave me was a newsreel, then a "March of Time," then war series single reel. The only thing to relieve the monotony of the weak blacks and whites of the newsreel camera were some coming attraction trailers.

While each unit had adequate entertainment values in itself, the program whole had just too much black and white, and war.

Which leads me to state that in many situations the short subject side of the program is maligned in the manager's office, and—let me dodge—in the projection booth. But first let's talk to the "boss."

To many managers, booking shorts is just another necessary evil, something to keep the film salesman happy and something on which to splice a trailer. They tell Putrid Productions, "Just send me a single reel of some kind," and pick up the well-worn copy of "Current Fishing."

Planning the Program

Let's survey the situation and see if we can improve our cinema package. Juggling Technicolor shorts is perhaps the best way to keep a variety of imagery before the customers, and the cartoon is the most popular tool to wield in this department. Most important, KEEP COLORED UNITS SEPARATED by black and white units, or in the case of a heavy monochrome program, the opposite.

So it remains the only way to build a program is to PLAN IT carefully beforehand. Add your running time, allowing average time for trailers. If your feature is under 120 minutes, hold your program to around two hours and a quarter. But always give your customers at least two hours of—we hope—entertainment.

What kind of picture are you playing? Is it a Technicolor musical? If so, you'd better book a black and white NON-MUSICAL short, along with your color cartoon and news—something serious to balance the levity of your feature. Is it a two-hour black and white tear jerker? Well, you'd better add a fast color cartoon to your news and cut a trailer or two somewhere.

Color suddenly flashing on the screen with a rush of music makes an audience sit up and take notice, but much more so if it has been preceded by black and white. Through two or three color shorts the eye becomes satiated with color and there is no new visual experience at the start of the long feature that requires closer concentration until the story thread is tied fast enough to glue attention.

The old law of opposites attracting each other is your best bet, and we hope it will attract customers, too.

Then there is the standard Saturday bill that keeps you off relief. We have "Horse Faced Rustlers," "The Mad Corpse Strikes," a "cliff-hanger," news and trailers. Here we have all black and white, but that doesn't stop us from scattering our shorts between the features. Let's start on the serial, giving them a short, exciting

"overture" to the long program to follow. Then between the features give them the news, with a colored trailer, if possible, stuck on behind. Finally make a dramatic change-over to the horror feature.

How Projectionist Can Help

But now let's climb the NEVER, of course, rickety ladder to the booth and tell the man how to run his show. Why must we assault the projectionist? Well, for one thing, in many cases he is thrown a bunch of cans to open and the contents to run in any manner he sees fit. Then there are his change-overs!

Presuming, Mr. Projectionist, you have already absorbed the advice given to the man in the office, and if it is your job to arrange shorts you'll do it properly, then set your foot on the automatic change-over button. That nervous foot makes me jump from my seat every time I watch a show from an auditorium.

"Time Marches On," crys the dramatic voice, and at the first note from the well-paid studio orchestra, zip! The lion starts growling on the feature, with the audience left in the air for what the ear demands; completion of the short musical theme. You may think audiences don't notice details like that, but if they don't say anything about it to the manager and may not consciously feel the omission, it nevertheless detracts. Any musician or your common sense will tell you when the note "ti" is sounded, the ear demands to hear the final "do."

It may be too much to ask the projectionist, who has just run two westerns and a serial, to wind off his shorts to inspect the endings and make a note of same on a little piece of paper for his reference. But one might find the film half way asunder somewhere along the reel too, and save a nice fire.

Before I start dodging the pliers, I will sympathize with you on your single reels that have been hacked by the scissor-mad short-combiners and sadistic trailer-splicers. Sometimes one finds only a few frames left on the end title. But that is not true on two-reel shorts! Usually they are left unscathed. And most hacked shorts have some of the final extended musical note if you'll only do some extra cue-marking—but NOT WITH A PUNCH, PLEASE!

Make Splices Properly

But why curse the other operators for butchering your short endings when you liberally remove frames in combining yours? I know a mid-frame splice looks bad on the screen, but not too bad if you do it properly. If there is a long fade-out on your short, get the frame line from the edge-marks and cut at the last frame before the white frame marks on the tail. Then splice mid-frame when you send it back, in order to save every millimeter you can.

Then there are the projectionists without a twelve-inch rule and the ability to count eleven between cue-marks and on leaders. Yes that leader is a "joner!" The length is usually so incorrect you make a practice of running it to about "4" and starting your machine when you see the preceding end title. Consequently you miss the fade-in, the starting music, and if there is a censor seal, you treat the audience to that also. But more about the seals later.

Nothing makes a smoother transition than a fade-out on one reel, a fade-in on the next, especially between shorts, if you are lucky to have those rare pieces of film intact.

The only way to accomplish this is careful measurement of leaders and footage between cues. Wind off your leader on an empty reel—NOT ON THE FLOOR OR REWIND BENCH! Measure back from the starting frame of the fade-in. If you live in a state without local censorship and are plagued with the state seals from the exchange area, remove the strip, because it will mess up your change, and how! One should throw them in the (we

hope) fireproof waste film can, but your manager will get a letter if you do; so to keep him and Putrid Productions happy, mount it on the tail with some black frames between it and the end title. It is better to let the screen go black than to show a seal if it isn't required in your state.

Measure to find the correct spot for "10," the best starting number if your action is quick and your machine picks up speed quickly; if not, "9" is a good compromise. Mark in "10" with the ugliest scratch possible, and perhaps the exchange will put on a replacement leader with the correct length. Place the number over the aperture and get that fade!

In splicing trailers especially, I suppose no projectionist is guilty of that violent "pop" we hear when it goes over the sound roller. Anyway, we will say that if you find a blank place between the two tracks, a bit of black crayon applied will keep the audience from dodging. Put enough on to make the clear area opaque. At the beginning of reels, a splice between the leader and picture can cause bad-sounding starts. Get your crayon after that also.

Now that the last reel of the picture is making an uncomfortable clang in the top magazine due to incorrect exchange rewinding, have you inspected the end of that feature to see how and if it fades out, and if you have exit music or a cast trailer, if you want to keep your lamp open? Or are you going to douse both music and picture at the final clinch before the music stops? Don't overdo it, though. We don't want "End of Part 6, flash, pop, flash," as we rise to leave.

"Would you call this a free version of 'Henry V'?"
"No, madam. It will cost you seventy-five cents."

A *Projectionist's* Day

W*hat* Goes O*n in the* Booth *of a* Large City Theatre

By WILLIAM P. McMURTRY

Just because a man gets a job as a projectionist is no reason why he should be expected to know every last detail of a projectionist's work. Good projectionists are not just born as good projectionists—they achieve that distinction through many long years of hard study and hard work. The man who admits he doesn't know is at the same time announcing his determination to learn, and that type of man is pretty certain to become a success as a projectionist —or in any other walk of life.

Today there are a great many men—yes, and some women—who have chosen motion picture projection as their life's work without too much of a background of experience. It is refreshing to find that most of these newcomers are perfectly frank in admitting their shortcomings, and fired with a determination to learn everything that there is to learn.

For that reason, it is probably a good idea to sketch out a general idea of just what a good projectionist is supposed to do in the course of a day. Once a newcomer masters the fundamentals of projection work, he can pick up the details as he goes along. The booths of the better theatres of our large cities contain many projectionists who may be considered as setting the standards of perfection, and who have a world of information to give to the beginner in the field.

The Esquire—Chicago

In deciding to call upon an experienced projectionist in a large city theatre, we chose the Esquire in Chicago. Located in the Gold Coast section of that city, it caters to a high class clientele, and has been known as one of Chicago's showplaces ever since its construction.

Lou Malisoff, projectionist at the Esquire Theatre

The same axiom that nothing was too good for the Esquire was carried out in the projection booth as well. The booth itself is large enough to afford ideal working conditions, and is kept spotlessly clean. Projectors are Motiograph Model K's, while the other major equipment items are also standard brands of well known manufacturers. The booth is equipped with a steel table, both automatic and hand rewinders, a rack of steel film cabinets, film splicer, and just about everything else in the way of equipment and supplies that any projectionist could desire.

The Esquire Theatre—a Chicago showplace

Lou Malisoff—Projectionist

The Esquire maintains a staff of two regular projectionists, who alternate daily on the matinee and evening shifts. On duty at the time that we were there was Mr. Louis Malisoff. Lou qualifies in every way as an experienced projectionist, for he has been working in the booths of Chicago theatres for twenty-five years, and has been at the Esquire ever since it opened. He works with an ease and speed that is a pleasure to watch—never missing any of the numerous details of his work and doing everything just about as it should be done.

There are five shows daily at the Esquire, with the first one going on at 1 P.M. and the feature of the last show starting at 10:30. The Esquire follows a one-feature policy, which, along with the Esquire Hour, completes the show. This last is something unique, and makes projection at the Esquire different from that in nearly any other theatre. The Esquire Hour consists of a portion of a news reel, followed by an animated cartoon, then by the Esquire Hour feature—which, at the time of our visit, was a beautiful two-reeler in Technicolor on the subject of America, the Beautiful—then by the remainder of the news reel, a quotation filmed exclusively for the Esquire, and several minutes of classical music from sound film.

A Typical Day

Let's follow Lou Malisoff around in the course of a typical day. Programs change twice a week at the Esquire—usually on Tuesday and Friday. There is a good deal of extra work when he has the matinee shift on the day of a new show, especially if schedules work out so that the Esquire Hour precedes the feature. This requires him to come to work about one hour ear-

lier than usual, inasmuch as the Esquire Hour calls for a vast amount of cutting of short subjects and splicing them together. The projectionist, incidentally, is permitted no deviation from the schedule, inasmuch as the hours at which the feature starts are advertised in the newspapers.

Under ordinary circumstances Malisoff arrives in the booth about half an hour before show time. The first thing to be done is to check the film. The films are checked against the program, and each reel is then inspected to make certain that it is wound right. The film is cleaned up when previous users have marked the print with red crayon or punch marks.

Every day there is a complete check-up of the projectors and of the other equipment, and it is remarkable how much Malisoff manages to accomplish in the half hour before the show starts. No better advice could be given to the novice projectionist than to make the same careful and complete examination of his own equipment every day. While it may take him more than a half hour before he acquires sufficient experience, it gives him a practical assurance that the show will go on without a breakdown.

A view of the ornate Esquire lobby

Checking the Equipment

Here are some of the things which we watched Malisoff do before the first show began.

Projector lenses were taken out and carefully cleaned with the special lens tissue which may be obtained from the theatre supply dealer.

The projectors were oiled with moderation, and all excess oil was wiped off. Both projectors, by the way, were kept so clean that they might be taken into a living room.

Film tracks and guides were given a good cleaning.

Both projectors were turned on for testing and warmup. This is a good idea, especially on a cold day.

Arc lamp reflectors were shined up, and carbon dust removed from the lamp houses.

Trim was checked to make sure that there was enough carbon to run the first reel. He informed us that when new carbons are required, he always checks screen illumination before the show starts.

The sound system was turned on without film, and the sound to the speaker tested with a card.

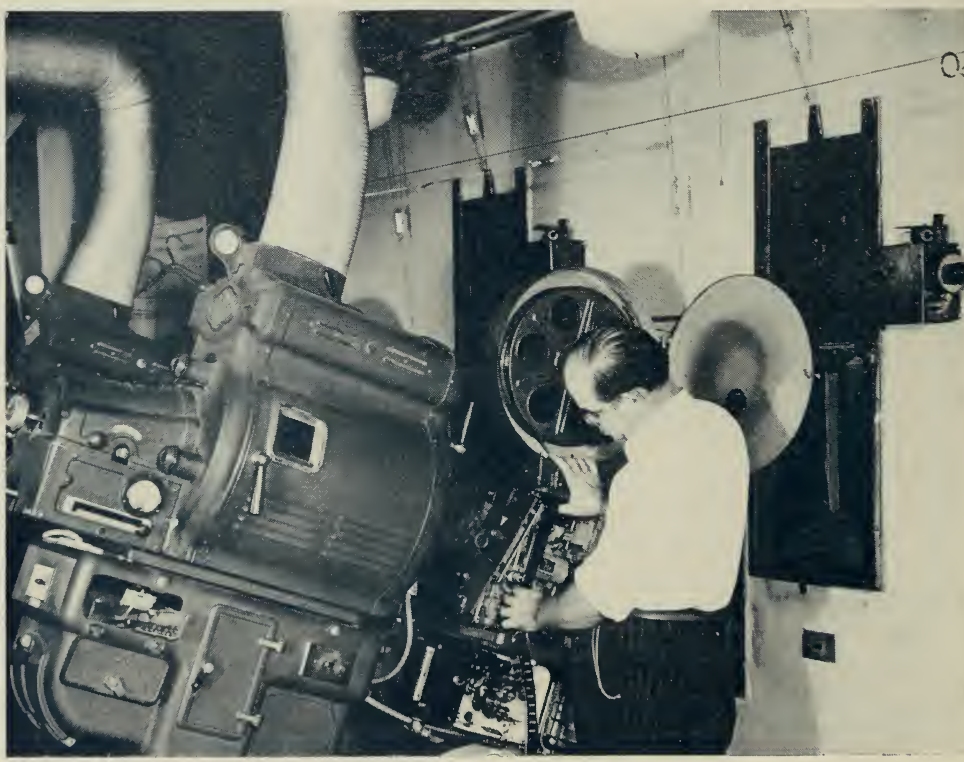
There was a check made of the vacuum tubes.

Sound heads were oiled, with all excess oil carefully wiped away.

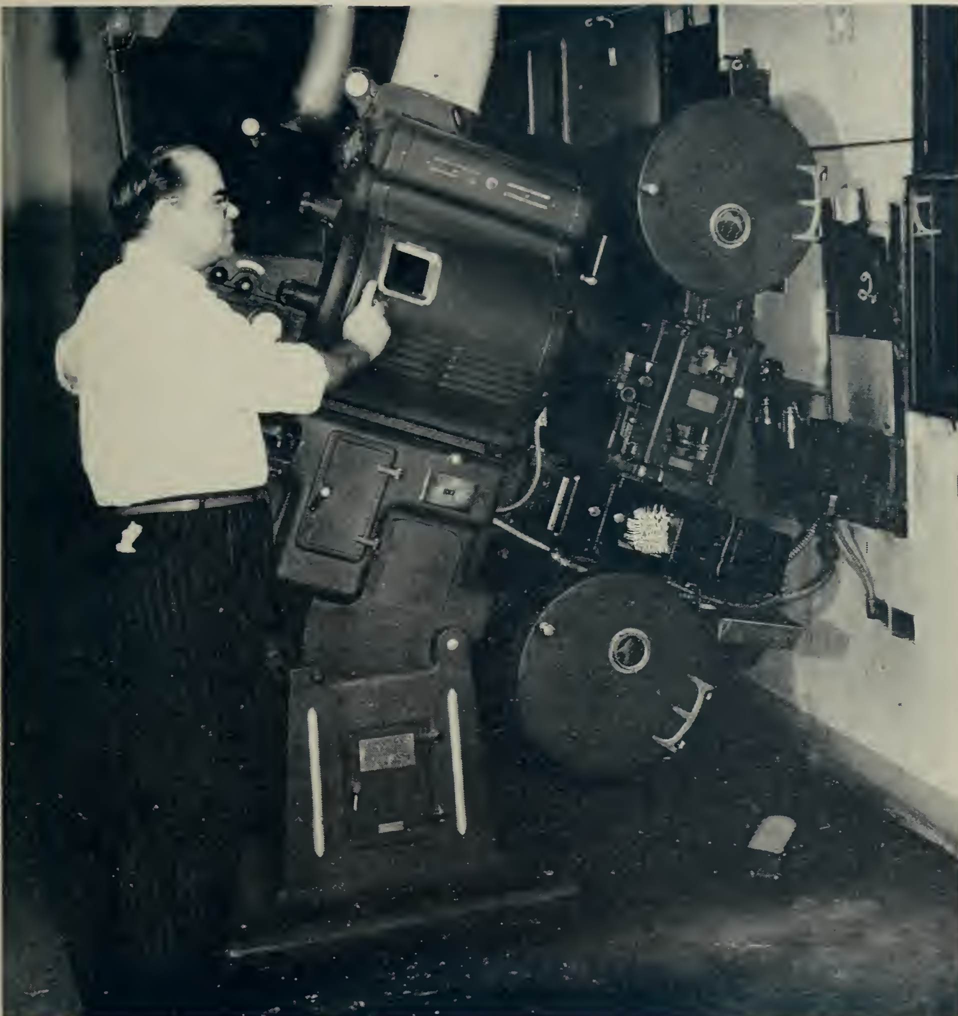
The Day's Work

With the preliminary check-up of the equipment completed, there was just time to load the projectors and get ready for the start of the first show.

One thing we noted particularly, and that is that the fire rollers were cleaned on all magazines—which is performed as



Lou Malisoff threading in preparation for the opening show



An alert projectionist checks lighting at frequent intervals during the time he is on duty

a daily chore. If all projectionists took pains to do the same thing, there would be far fewer disastrous film fires. Most fires start at the aperture, and if the fire is kept from spreading to the magazines by efficient fire rollers, there is little likelihood of it turning into a disastrous blaze which might destroy the theatre—and what is more important, take the lives of the projectionist and the patrons.

Inasmuch as this was the first run of the feature, Manager Paul Hess sat at a porthole in the projection booth during the entire running, carefully checking lighting

and sound. Signals from the assistant manager in the theatre regulated the volume of the sound, which, because of the size of the Esquire, must be increased or lowered as the theatre fills up or empties. While the feature was running, Malisoff was busy splicing together the various sections of film which go to make up the Esquire Hour. What with change-overs, loading and unloading the magazines, rewinding film, splicing, and watching the lighting and sound, we would say that there was little time to sit around and read the paper—the traditional custom of which one hears so much and sees so little among projectionists.

When working the evening shift, the Esquire projectionist gives a final check to the booth and straightens up before leaving for the night. On those nights on which the run of a film concludes, there is about one hour's extra work taking the Esquire Hour apart and resplicing the films to the original form in which they were sent to the theatre.

No wonder that the Esquire is one of Chicago's favorite theatres. It has good management, good projection and good equipment. That's always a winning combination.

A corner of the powder room at the Esquire

PART TWO

THEATRE MANAGEMENT AND MAINTENANCE

Summarizing Showmanship

Principles of Successful Theatre Operation

By CHARLES H. RYAN

Assistant Zone Manager, Warner Bros. Circuit, Chicago

Successful theatre managers adopt a consistent satisfactory policy based upon standards of sincerity. Your theatre is your community's playground of life.

Maximum service at minimum cost is one thought that should be carried at all times in the back of your head. Once you have earned the "Good Will" of your public, you have an asset that cannot be bought at any price. "Good Will" is easy to attain if you will make up your mind that the best is none too good for your patrons. Make friends with your customers and go out of your way to do favors.

Once you have acquired the "Good Will" of your neighborhood, you will continue to enjoy a well-balanced patronage in spite of the fact that there may be a more palatial and more comfortable theatre in your locality. With your patrons you can cement a friendship in some small way. No matter how trivial a patron's request, extend yourself just a bit more than is required.

Many an independent community theatre without all the film product and labelled by smart exhibitors as a so-called "lemon," suddenly becomes a money making proposition when a manager or owner steps in who has the ability to make friends.

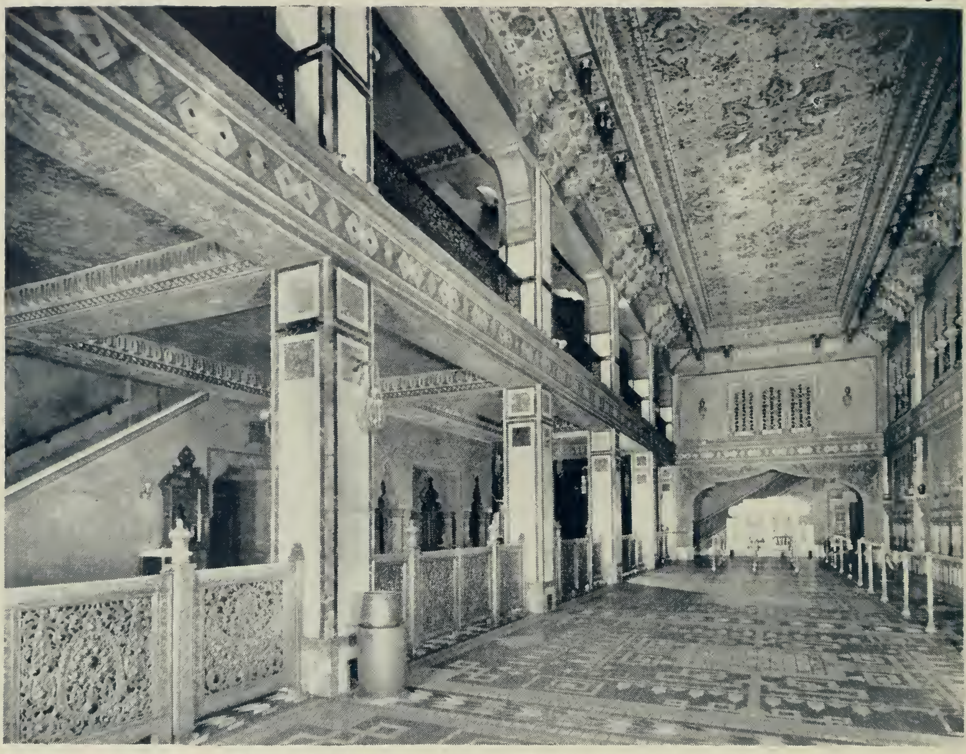
Value of Good Will

Appearance and courtesy rank about equally in making a place of business attractive. A manager of a theatre is a merchant engaged in selling a certain commodity to the public, and he depends upon the "good will" and satisfaction of his patrons for a continuance of their patronage.

Pictures are, of course, the biggest part of a neighborhood theatre's claim for recognition, but they are not everything there is to talk about. Let every manager keep his house so spick and span and inviting that he can brag about it with justifiable pride along the lines of institutional "GOOD WILL" copy.

Good-Will is the acquisition and the expression of confidence and respect. It is the "giving" of something—something beyond the mere value of what is sold. For no business can endure or be successful unless there be "giving." Important, however, is the fact that one must know how to give, what to give, when to give and whom to give it to.

Much has been written of and talked about the dispensing of Good-Will from the theatre, and much has been and is being done about it. The rank and file of each



The ornate beauty of the Avalon Theatre, Chicago

individual theatre are daily writing in the book of Good-Will.

It's all in the day's work! We must not overlook the fact that the motion picture theatre business is a partnership—a partnership with the Public. All partnerships, if they are to succeed and endure, must enjoy Good-Will.

Theatre Atmosphere

A truly successful manager is the one whose theatre is considered the dominant theatre in his community. His theatre is accorded first place because of the spirit that dominates the employees, because his advertising invites confidence, and because the service that is offered to patrons stands supreme in his community.

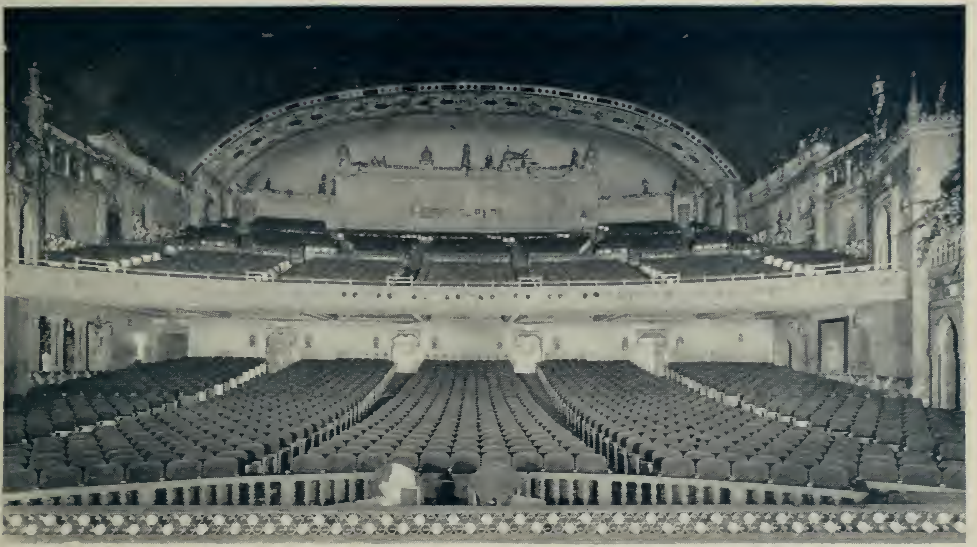
A theatre that carries with it an atmosphere of gloom cannot be successful. Theatre-goers are looking for diversion and happiness. Therefore, it is not surprising that they will give the "Gloom Theatre" absent treatment. What we need most in any theatre is atmosphere that will gladden a patron for an entire performance.

When you cannot find institutional values to exploit you admit failure or lack of ability.

But only you and your staff can bring forth the selling angles of your theatre. Plug your theatre regularly so that every potential patron will be conscious of those things which help make a good show more enjoyable in an atmosphere of refinement

and comfort.

A successful theatre habitually sells the idea of the house, even though the feature program may be a little weak. Theatres that sell themselves on the institutional plan always have present the general suggestion of cordiality. It is not the pretentious cordiality, but the quiet welcome of genuine management . . . the smile with the ticket sale, the doorman taking his share of the ticket quietly instead of snatching it.



View of the Avalon auditorium

Give your house a PLEASANT PERSONALITY, and if you have a flop picture, you still can hold up business. Habit to movie patrons is contagious. If you get them started, they will remain your patrons as long as they reside in your neighborhood.

Courtesy is not a handwringing, bowing attempt at goodness. It is a spirit that must radiate out from the heart and head and hands each moment of the day. It is confidence, enthusiasm and calm to encourage, inspire and attract others. Courtesy gives atmosphere to your theatre.

Successful merchandisers who sell to the public attribute their fundamental success to the simple creed, COURTESY. Courtesy is a magnet for satisfied patrons.

Good Managers Needed

The man who is in demand today is a good house manager, exploiter and theatre operator with the ability to first perfect a well organized and clean theatre, and then turn his attention and time to selling his shows. Ability, enthusiasm, willingness and energy are the most important factors that count in rating a good house manager.

There is always a reward for the man in show business who does his work painstakingly with completeness. He is the man who will be trusted with responsibility up to the limit of his capacity. *Soft jobs come to those who have done hard jobs well.* So called "easy money" is delayed compensation that comes to the showman who has earned "hard money."

Duties of Manager

The alert manager never leaves things go

until the last moment. That is why he is alert. Any manager who neglects his theatre, or waits for emergencies to prove how fast he can attend to them, will never have executive ability. An executive knows how to plan his work in advance.

To ascertain the likes and dislikes of his patrons, a manager's place is on the floor of his theatre. Necessary clerical work should be taken care of in the office during the matinee performance.

The patron is always impressed with the presence of the manager on the floor, and it is his duty and obligation to create a favorable impression on his patrons. The theatre staff will also function better if the manager is in his place on the floor each evening.

If you call yourself a good manager, you should know what's wrong in the projection booth when there is trouble. You must be able to sell tickets with a smile better than your cashier. You must know how to usher so that you can see that the staff is doing their task right. You have to know how to create business-getting advertising which will bring new patrons and keep the regular ones.

Managing a theatre is a specialized business. You sell only one commodity—ENTERTAINMENT. Everything should be done for the greater comfort of your patrons, so that when they leave your theatre they will leave with a strong impression of its good management.

You should visit other theatres when time permits and see what is going on in different theatre surroundings. You, in your own theatre week-in and week-out, get into a rut, and some of the faults others see in your theatre escape your notice.

Your patrons visit other theatres and compare your house with them. Make it a point that the opinion your patrons carry away on leaving your theatre is that it is operated as well or better than most of those they have visited either downtown or in other localities.

Managers can ascertain the likes and dislikes of their patrons by occasionally speaking with them in the lobby. The subject of the conversation can be: "What types of pictures attract you to our theatre?" All moving picture fans do not agree on any one type of picture, but you must try to ascertain what the majority will leave their homes to see.

In many ways, your hands are not tied in operation. Your community has its own peculiarities about its entertainment and amusement. There is no one better suited to meet the demands of your patrons than the man on the job—the manager.

Do you know from past experience what type of pictures or what stars rank at the top in your past box office receipts? What might hit in one community might be a terrific flop in another. When the monthly booking releases are announced, you, in booking your pictures, should have reasons why you want to book this or that picture for certain days of the week.

After setting his releases, a wise manager will sit down at his desk with his bookings before him and pour over the various facts he knows regarding the pictures from the opinions he has gathered from first-run results. Wherever he can make a change that will improve his bookings, he should do so. We have found out from experience that a smart booking will outgross a bad booking on a three day run as much as several hundred dollars.

Your superiors may send out suggestions on what to book, what to advertise and how to run your theatre, but still you do not have to be a "yes" man. If you can give your superior facts as to why certain pictures or advertising are suitable in your theatre, he will be guided by your judgment.

Have some individuality and stand by it but not to the point where you fail to carry out the orders of your superior. You need not be afraid to tell your ideas to your executives if they ask for them.

Every successful showman encourages a frank discussion on items subject to controversy, so that he may be sure he is right

in making his decision. No man is too big to welcome suggestions from his men, especially from those who have really good and practical ideas to submit.

Do not let your will power die out. Your theatre must show life no matter how tough your problem. The value of your services is gauged by your judgment of what is profitable in your theatre.

on time is during the slack period between four and six. Operators must never be permitted to leave out any film without your express approval.

Managers can always obtain the exact running time of features by phoning prior-run theatres. If it is necessary to eliminate a feature trailer, do not do it in the peak performances.

Lobby of the Jeffery Theatre, Chicago

Arranging the Schedule

If a performance runs three minutes over schedule on the first show and your policy is four shows, the end of the day would find you twelve minutes over schedule. Therefore, when a show does run longer than anticipated, the schedule should be rearranged immediately after the first show. If necessary, a new schedule should be made for the following days. The proper time to make adjustments to get back

Handling Employees

Study closely the types of people who are working for you and their reactions to your orders and suggestions. Find out just how much "producing value" each member of your staff possesses and help bring out the best work that is in him.

For a manager with the best interest of his theatre at heart to merely tell his employees what to do is not enough. It is much more important for him to create in them

the desire to do what is best for all concerned. To do this requires patience and understanding of those with whom you are dealing.

Find the person best fitted. For each task certain personal qualities are essential. In each person certain qualities dominate. Find the person best fitted.

Win cooperation. Cooperation means working together. It cannot be demanded. It must be won. Accept your share of responsibility. Respect the rights and aspirations of others.

Must Have Good Equipment

Many a good show has been ruined because the sound was too loud or too soft, or that the picture was out of focus during the greater portion of the running time.

Proper projection is one of the most important phases in theatre operation, and the managers and their assistants must make sure that the picture projected and shown on their screen meets with the most exacting standards, which are outlined in perfect theatre operation.

Advertising and Trade Papers

Make it clear in your advertising that your house is worthwhile. Adhere to a high standard, and make your theatre a community institution. In a message to your patrons, drive home a well-defined idea! Connect with such chummy chats sales ideas with a decidedly intimate atmosphere that will subconsciously give the reader an impression that he is being personally addressed. This will go a long way towards bringing about a close bond of understanding between your theatre and your patrons.

You will find a lot of good terse little sales arguments in magazines and newspapers that can be applied to movie merchandising.

No theatre man should be without a copy of every issue of the well-known trade papers, because they are as important authorities on our business as any medium he could possess.

There are always suggestions in these publications that tap new sources of patronage and outline how others have successfully approached some ticket selling problem.

Ambitious managers will scan the trade magazines for novel ideas that may prove adaptable and serve to remind of others. Compile these clippings in a scrap book that will be a constant and quick reference in your efforts to call attention to your theatre and its attractions.

Newspaper Advertising

In analyzing the various forms of theatre advertising, the medium that has been proven most valuable is newspaper advertising and publicity. It is the best form for successful seat selling, and here are several reasons:

1. It reaches the masses by good coverage and circulation at a minimum cost.
2. In the homes, it awaits the reader's leisure.
3. Your ad is inserted in a publication that has constant reader interest day after day.
4. The morning editions are read by the man, woman, boy or girl going to work; the afternoon paper gets into the house when the family is formulating their plans for the evening's entertainment.
5. The worries of distribution are eliminated, because of organized sales and distribution.

Women Are Important

Direct most of your advertising to the female sex. Women either spend the "dough" themselves directly or influence the ways in which it will be spent. Advertising is the means through which you can lure the women. Single or married . . . young or old . . . romance is one thing that interests them. Get that appeal in your copy . . . the heart interest, the heart throbs, the things they can picture as happening in

their own lives.

In planning advertising campaigns it has been established that women become the objective—they constitute the major percentage of patronage, or at least cast the final vote in the home determining the majority patronage. The manager who knows what the women patrons want always makes it a point to include in his advertising copy an illustration or announcement that is meant for the perusal of the general feminine patronage.

Cultivate Child Patrons

The child is the most important patron to be cultivated! Children are born great talkers, and their word-of-mouth advertising is valuable in ticket selling.

The theatre manager should get to know as many children as he can. Be mean to a child and he will never forget it. Where children go—there also go their mothers and fathers.

Make your theatre and shows as attractive for the kids as is humanly possible. Catering to the children will get your theatre talked about favorably with the parents, uncles, cousins and aunts. Those who are led will attend your every-day performances, and many of those so led have never been there before.

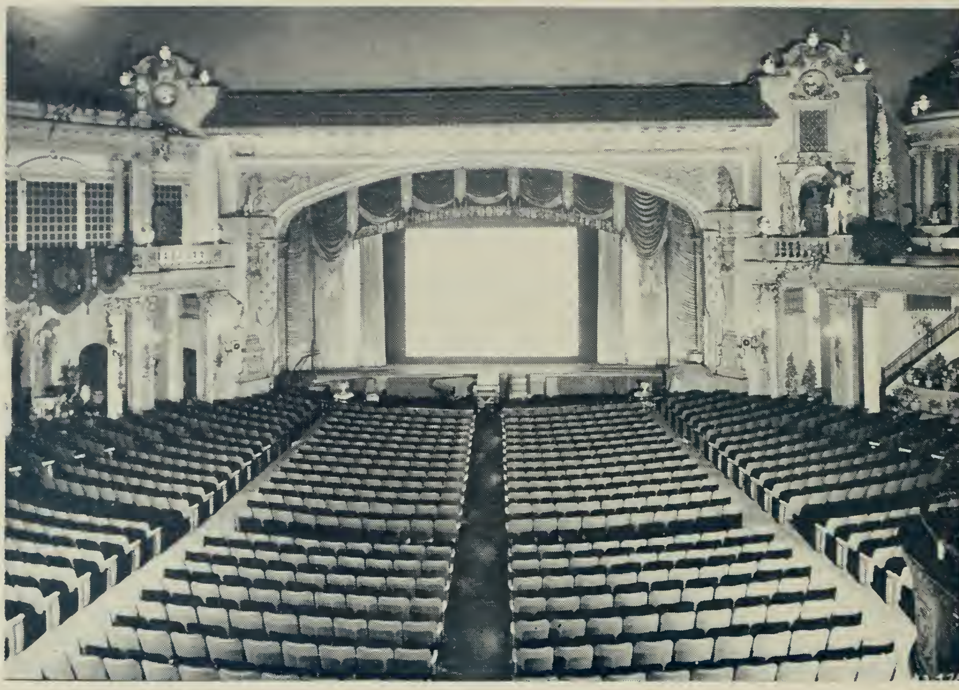
Clean Rest Rooms

It is the first essential of a cleaning inspection to check the condition of the rest rooms. Invariably, an untidy rest room means an unclean theatre. One way to overcome a condition such as this is to have all the necessary cleaning and maintenance supplies readily available for your janitor staff and patrons.

Make it a point to see that an usher inspects the rest rooms, especially the ladies room, not less than once every two hours. Also have the matinee cashier give you a report on the ladies rest room when she is relieved on her shift by the night cashier. This applies to times when a matron is not on duty.

You must know the saturation point in

A study in illumination—Warner Bros. Beverly Theatre, Chicago



Interior of Warner Bros. Capitol Theatre, Chicago

controllable expenses, and you should not overstep these amounts. A manager can control his expenses if he keeps records and knows when to effect savings without jeopardizing operation. If there are any abnormal changes that have occurred in any period, be familiar with them so that in explaining the results of your theatre in any given quarter, you can account and explain the reason for each item.

The theatre manager who informs himself adequately about his operating costs and who does his work so well that he needs no help in correcting his "expense leaks" is on the safest road to achievement.

A few businesses prosper exclusively on transient trade. It is the repeat customer who pays the rent and some of the profits in any business. This is just as true in the motion picture business as in any other business.

If we know a person's habits, then we can take steps to keep alive that habit which concerns us. If you know that a person frequents your theatre, you can keep that habit active by keeping him interested in your theatre and in the entertainment you project on the screen.

Time to Plan Ahead

There isn't any sentiment in Show Business. Its place is taken by RESULTS. All the hard work you may do won't wipe red ink off the books unless that hard work is directed by intelligence and deep thought.

Today you are a student of the theatre—of public reaction—of theatre conduct and management. Intelligence, hard work and creative ability will always be the attributes which focus the spotlight of attention on the individual in the crowd.

The lush days in show business may soon

be over and some thought and planning must be given to keeping the flow of patronage from falling below normal. In fact, it must be kept well above the normal, because of the increased operating costs, taxes, etc.

The task of "building back" will be easier for the showman who has ever been watchful of his theatre's place in his community, who has kept up his efforts to sell it institutionally as "a place to go," as a habit.

Showmen should ever be mindful that show business will one day be worse before it is better and we should be building our individual and collective fortifications now against the possibility of another horrible depression, a depression we will doubtless feel, but to what extent depends entirely upon our efforts now.

The time to plan for the future is today, for today is the tomorrow of yesterday.

• • •

A courteous employee benefits his theatre as well as himself. Most big executives are those who have the ability to get along with others, and courtesy is an important factor in "the ability to get along."

• • •

Were the early jobs of thousands of theatre owners, managers, and other theatre executives checked carefully, many hundreds would say, "I started in this business as an usher." A shrewd exhibitor will point out to his ushers that there are promotions and financial rewards ahead for those ushers who do their present job well.

• • •

Learn everything you can about show business—that is good advice no matter what your capacity in the theatre world might be.

• • •

The usher is the host of the theatre. If he is not a good host, your guests, the patrons of your theatre, may not want to make a return visit. The good exhibitor therefore will try to impress upon the usher or usherette the importance of treating each patron as a welcome guest.

HINTS FROM THEATRE HEADS

Interesting ideas are often contained in letters from executives who know theatre operation from years of practical experience.

I think it would be swell if you would have a space called "Why Not?" filled with ideas sent in by men in the theatre business, such as I am enclosing on the back of the letter. Some ideas already field tested, other ideas and suggestions that would help others.

CHARLES R. BARNES

Treasurer, Fox Wilshire Theatres
Beverly Hills, California

The sample suggestions mentioned by Mr. Barnes and enclosed with his letter are printed below.

1. Invent a gadget to be attached to the ticket machine that stamps or prints the day and date on each ticket as it comes out. Use a quick drying ink.

Why?

This would save theatres lots of money in many ways.

A. A doorman who is palming tickets to sell the next day to friends or others could not do so.

B. Patrons who are standing in a hold-out line and who are missed by the doorman may not use the tickets again.

C. A change theatre, such as the firm I work for, which uses the same color of tickets each day throughout the year and also the same tickets in price and color at eight other theatres may put a stop to patrons who buy tickets, and after finding that there is a wait for seats, go to other theatres and use the same tickets. It happens a lot here.

2. Have a book printed for ushers, usherettes, doormen and cashiers as to the rules and regulations of the house, and also signals and other vital information.

• • •

I think that every theatre should pay more attention to its music programs before the start of the show, and not leave it to the operator to play only records of his choice. We lay out a music program for every show, list records in the order they should be played, and start 12 minutes before the first reel. It's surprising how many people come in early to hear it.

HARRY B. HUNT

Hunt's Casino Theatre
Wildwood, New Jersey

Good Theatre Management

A Guide of What to Do and When

By CHARLES H. RYAN

I intend to give some of the every day details which experience has shown to be essential to good theatre management.

I am aware that much of what I say will be "old stuff" to those veterans who have passed their lives in show business. I know, however, they will understand that I am talking primarily to the many new men and women who have been brought into the motion picture industry.

These new owners, managers and assistant managers need all of the help which we can give them.

I hope that what follows will be helpful to them.

Importance of Projection

Since the sound picture is the merchandise that any theatre is selling, the projection booth is the "heart" of your theatre. It is imperative that managers acquaint themselves with their operators, their booth and its equipment.

The manager should check to see that his operators are caring for the equipment in the booth. Make sure that they have clean rags to wipe down the machines, sufficient oil to care for the moving parts of the equipment. Check to see that they are keeping clean and polished the reflectors and lenses. If you have glass port hole covers, see that these are cleaned daily. A small accumulation of dust on these ports can result in a great loss of light on the screen.

It is essential that you use the correct grade of oil as recommended by the manufacturer of the equipment, when oiling any part of the projection mechanism.

It is of the utmost importance that your operator realizes the necessity of carefully handling the film and seeing that it is kept clean and is not mutilated.

Always remember the focus of the projection equipment must be changed when you are showing a Technicolor feature or short subject. All operators are familiar with this, but many neglect this important operation. For the best results from any Technicolor print, change focus to accommodate the change from black and white to color.

Keep the Booth Clean

Cleanliness in the projection booth is a MUST.

Make sure that the operators keep the equipment clean at all times. See that they are supplied with cleaning rags. Dirty projection equipment causes fires, unneces-

sary wear and is responsible for fading or loss of sound. Visit your booth frequently. Your main job is seeing that the operators keep the equipment cleaned and well oiled.

Every manager, new or old, should acquaint himself with all electrical switches controlling his sound projection system. Know, and clearly mark, exactly what each switch controls. In this way, a stranger to your booth will be able to check every possible source of electrical failure. Also, maintain a permanent list of the fuses required in your booth, and keep an ample supply of spare fuses within easy reach. This will eliminate shut downs, refunds and loss of revenue.

When Trouble Comes

Sooner or later in your capacity as manager or assistant, you will experience trouble in the projection booth. When this occurs, the first thing to remember is:

"DON'T GET EXCITED"

If in the event of a breakdown in your theatre sound system, allow your operator a reasonable length of time to locate the trouble. If he is unable to remedy the trouble, then it is time to call for help.

Before placing the call for an engineer, or your theatre equipment dealer, find

A clean and well cared for theatre will attract patrons (Highland Theatre, Chicago)

out from your operator what he thinks the trouble is and describe these symptoms when you call. Oftentimes, from your description of the trouble, the engineer or dealer can direct you to the source of trouble, and your operator can make the necessary repairs without the EXPENSE of an emergency trip to your theatre.

Inspect your chairs regularly, and keep them in repair

Don't ever attempt to make repairs or "tinker" with the sound equipment yourself. Remember, your sound system is a precision instrument without which your theatre cannot operate. This equipment should be handled only by an expert.

Watch Sound Carefully

The most important thing to do is to establish the proper volume of sound for your theatre. Sound volume should be such that the patron is able to relax in his theatre chair and hear every word plainly. There should be no straining or tension. Never permit the sound volume to be too high and "blast" the patron from his seat, nor to be so faint that it is a mere whisper.

It is the MANAGER'S personal responsibility to not only carefully watch the sound level in his theatre, but to train his theatre staff to be equally adept at correcting faulty sound. Regardless of how good a picture may be, it can be completely worthless to your patrons if it is not presented with the proper level of sound.

In regard to the proper sound volume so that people will not exert themselves to straining to hear, I have had several occasions recently where I entered the auditorium of our theatres and found the volume so low that the people could not get the dialogue. Managers should pay particular attention to this phase of the business because some of the best comedy of certain pictures is absolutely lost to the audience due to the fact that the operator is not signaled or has not been instructed to move his fader up.

Managers should at all times have a trained employee in the auditorium to watch the sound. If no employee is available and the doorman is close enough to the auditorium, designate him as the one to watch for the proper sounding level in your theatre. This is the only merchandise outside of the sight entertainment we are selling. See that the ear entertainment is just as good as the eye entertainment.

Keep Screens Clean

Screens can be dusted by using a camel hair brush and by vacuuming. When using the vacuum, make sure that you use the brush attachment, and then, only vacuum the rear of the screen. Be careful not to put the dust onto the face of the screen.

You can protect your screen and help prolong its life by following these two suggestions. Keep the back stage as free from dust and dirt as possible. Never per-

mit an accumulation of old equipment, lumber, signs, etc., back stage. These gather dust and dirt, and when moved this dirt will tend to gather on the screen. If your theatre is equipped with a traveling stage curtain, always close at the end of the show, and keep the curtain closed over night and during the time the theatre is cleaned in the morning.

Dirt on screens is responsible for a terrific loss of light, and the quality of your projection suffers. Keep the screens as free from dust as possible.

Guard Against Dirt

Dirt and dust are the two greatest enemies of all mechanical equipment, and by installing an efficient "check" system, you can forestall costly breakdowns before they occur. A well maintained theatre is a safe theatre. A clean theatre is free from fire hazards.

A thorough inspection of the theatre before closing for the night should be a MUST to all managers. All remote corners of the theatre should be inspected.

The manager of a theatre has a unique obligation to the community and his patrons. Nothing short of perfection is enough. Many new responsibilities have been placed upon the theatre manager in the operation of his theatre and the training of his staff to meet new emergencies.

Remember, your patrons look to YOU for their Comfort and Safety. You can obtain these results by maintaining a CLEAN and well cared for theatre.

The mosaic tiled lobby of the Capitol Theatre, Chicago

Fire Escapes and Exits

All fire escapes and exit doors should continually be examined to determine whether they are in good working order and whether there is any indication of rust or other deterioration. Check for loose bolts, angles, supports, etc.

It is your duty to take every precaution to protect the hardware on the doors of your theatre. All doors, panic bolts, hinges and locks should be oiled to protect them from any undue wear. Check the fastening screws on all these items and on all door pulls, etc., to prevent strains.

Door closer, or door checks, should be given all possible care. These should be kept clean and oiled.

Inspect Marquee and Roof

Roof inspection is important to any well operated theatre. Leaks in a roof may mean damage to plaster work in the theatre. It is imperative that the marquee and the theatre roof be inspected frequently and defects repaired immediately.

Your theatre front is your show window —Rhodes Theatre, Chicago

The flashing or coping on the roof parapet walls often becomes defective. This allows water to seep into the theatre, and therefore should be closely checked.

Downspouts and gutters are to be kept free of rubbish, and should be inspected for signs of rust or deterioration.

If you have a water tank on the roof, the supports, ladder and platform should be examined. Exposed areas should be painted to prevent deterioration.

Theatre signs that are supported from the roof should be examined for signs of rust on the steelwork, bolts, rivets, chains and guy wires.

See that any electric wiring on the roof is well insulated and supported. Mechanical equipment on the roof should be inspected as frequently as that inside the theatre.

When there is a heavy snowfall, see that snow is removed from the roof and marquee. Snow should especially be removed from skylights. Care should be taken when using shovels to remove the snow that damage isn't done to the roof surface.

Vacuum Cleaners

Clean the vacuum cleaner tank and bag daily to obtain maximum efficiency from the cleaner. Instruct your porter not to use the sweeper to pick up sharp objects, as they rip or cut the bag.

Handle the electric extension cord on your sweeper with great care. Don't yank the plug out of its socket by the cord. Grasp the plug itself. Always wind the cord loosely for storing so that you don't damage the fine wires inside. Do not allow wire to become kinked or twisted.

The motor should be turned off before removing the plug from the wall socket.

Theatre Chairs

Inspect your chairs regularly. Do not allow the seat standard to become loose,

as it allows a great strain to be placed on other portions of the chair.

Tighten up all loose attachments. Use care with the screw driver or wrench as hasty and careless repairs often burr screws and deform nuts. These burrs and cutting edges are responsible for damaged clothes and stockings.

The hinges on your theatre chairs are like any other piece of mechanical equipment and need an occasional oiling. Remember, a little lubricant where it is needed is a great deal better than too much. Be Careful . . . too much oil can spread to the entire chair framework and soil patrons' clothing.

Care of Carpets

It is necessary that all managers do their utmost in caring for the carpet.

Remove gritty dirt. The presence of any gritty material in the pile of the carpet may cause considerable wear. The only satisfactory method of removing such grit is by the use of your vacuum sweeper. See that your carpets receive a thorough vacuuming daily.

Remove spilled materials as soon as possible. If spots or stains get on carpets or upholstery, they should be removed before they have a chance to soak in and dry.

Breaks or tears in the carpeting should be repaired immediately. Do not allow a tear in your carpet to remain unrepaired for any length of time. It should be sewn before the tear or break is made larger by the normal flow of traffic on your carpet. This is also a great accident hazard and has been known to cause serious falls.

Do not allow carpets to become excessively wet. Water will deteriorate the pile and the threads of the carpet and cause them to wear out before their time.

Save Electricity

It is important that you become familiar with all electrical outlets and switch boards in your theatre. All switches and circuits should be marked—showing exactly what each controls.

Do not allow ushers to flash their lights on and off unnecessarily. Keep batteries away from heat. Heat causes expansion of the contents and will burst their containers. Prevent dropping of batteries. This will open the seams of the containers or crack the top seals, permitting the electrolyte to leak out. This applies to all dry cell batteries.

Make sure that your cleaners and porters are equipped with and use, work lights so that they do not burn the large theatre lights while cleaning.

See that outside exit lamps are not burning in the daytime.

Don't turn on house lights prior to opening other than for sufficient time to check the theatre, and to make sure that all lighting circuits are in proper working order.

Front of Theatre

Always bear in mind the fact that the front of your theatre is the show window of your business. It is from the front and the appearance of the front that the prospective patron gains his impression of your theatre. If it is unkempt with dirty displays not properly and attractively shown, you are apt to lose a customer. All because the manager did not take an active interest in this important phase of his business.

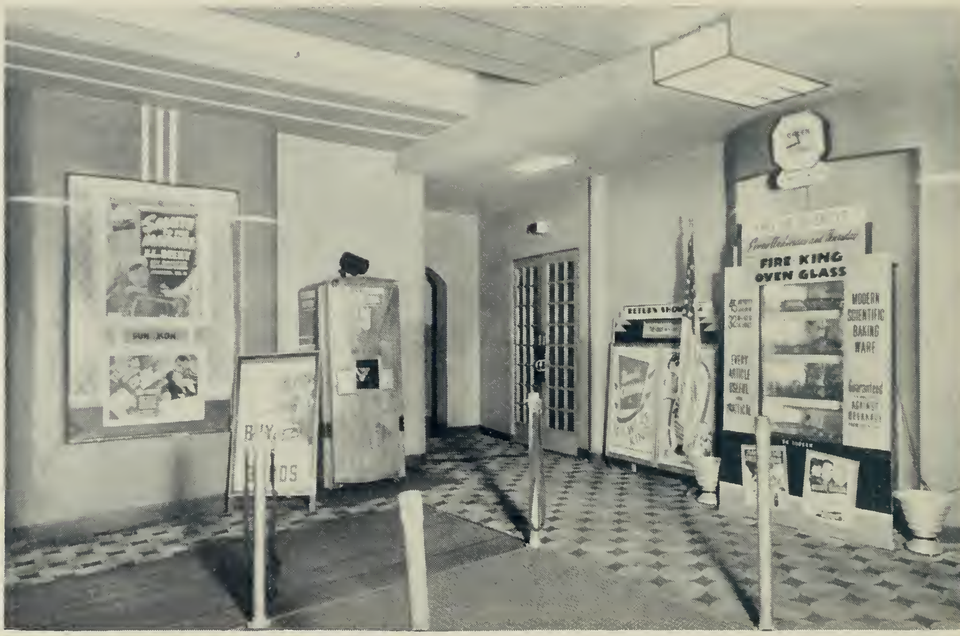
Your changeable letters should be constantly washed, painted or repaired. Have your sign man, or usher, wash every letter before it is placed on your marquee. He can do this as he makes up his sign change.

Dirty backgrounds detract from the value of a marquee sign.

Keep Displays Attractive

Your display frames in the front of your theatre are truly your show windows. This is where you display the merchandise you are selling. Consequently, every effort should be made to keep these displays attractive. Make sure that the glass on all frames is kept clean and free from finger marks. Washing the outside, painted fin-

ish of the frames once a week will keep them from looking dull and unkempt. If you have chrome on any of your displays, make sure that the porter wipes the chrome daily. Chrome can be kept attractive by merely wiping it with a damp cloth and then polishing.



Displays sell your coming attractions—Orpheum Theatre, Hammond, Indiana

Date snipes on all displays are important. Make sure that every display piece is correctly dated so that patrons can tell at a glance when the attraction is playing your theatre. Date snipes are inexpensive. They are important. You've got to tell them WHEN, as well as WHAT. Keep all date snipes clean and neat. If, through constant use, they've become dirty, punched with thumb tack holes and torn, get new ones. They'll add to your displays.

Box Office Makes Impression

How about your Box Office? Every box office in every theatre uses one or two signs of some sort. Are these signs clean, neat and legible? Do they tell the story? More than any other place in the theatre, your box office is the patron's first contact with the theatre and its personnel. Make doubly sure that their first impression is good. Keep the box office clean and orderly. See that your price and policy signs are in good order. Also, make sure that your cashier does not allow her friends to detract from the advertising value of your box office by loitering and loafing around, in most cases covering up the signs you want your patrons to see.

You may not think of your box office as a medium of advertising, but it is. Institutional advertising, maybe, but it really is direct contact advertising and its value should not be lessened by dirty signs and loiterers.

Although this is not advertising in the strictest sense, the cleanliness of the sidewalk and curb in front of your theatre is important to the money you have already spent to dress up the front of your theatre. None of us would spend a lot of money for a fine living room rug and then use packing boxes for the chairs and tables. Keep the front clean of all rubbish and refuse. It only takes a broom and a few minutes, and it will enable you to show off the front of your theatre to the best advantage to prospective patrons.

Lobby Displays

Keep a constant check on all inner display frames. Make sure they are always filled and that material is properly dated. As on the front displays, snipes should be clean and properly placed. NEVER ALLOW A BLANK FRAME IN YOUR LOBBY DISPLAYS. See that they are filled with something at all times.

Your lobby, if you have the room, is an excellent place to "sell" your coming attractions. Many theatres have had small "coming attractions" monthly boards made up. These boards list the entire month's attractions that are coming to the theatre.

Screen Trailers

This is the most important medium at your command for selling your attractions in advance, and should be carefully watched to see that it is being handled properly.

Watch your trailers closely. Make sure they are properly dated and sniped and be sure that the snipes are of sufficient length to allow easy readability.

The spotting, or placement of trailers in your program is very important. Do not overcrowd your screen with trailers of coming attractions. Remember, patrons attend your theatre to see the show, not to see a lot of advertising. They want to see what is coming to your theatre in the near future, and appreciate the showing of prevues. But do not overdo it.

"I *Want a* M*anager*—"

The following article was written by a well known executive with a background of experience dating to the early days of the motion picture theatre.

I had the pleasure of being a guest at the home of a very prominent chain theatre executive. He was enjoying an afternoon of rest, after working twelve to eighteen hours every day over a period of several months.

This, as I have said, was an afternoon to relax, in house slippers and lounging coat. But he wasn't relaxing. His extreme nervousness indicated only too plainly that he was worried about something.

He told me all about it when I asked him what was wrong. The average new manager simply didn't seem to understand a theatre manager's duties.

Well, we all have our own ideas of what the ideal theatre manager should be. The requisites which he listed, however, are particularly good ones in my opinion. Most of the older theatre managers know these requirements. It is just possible, nevertheless, that you have forgotten some of them, and so I believe that these suggestions may be helpful to all of you.

Requisites of a Good Manager

"I want a manager," this exective said,

"who will do more than simply open the doors fifteen minutes before show time, and then forget all about his theatre after closing time.

"I want a manager to realize that he is a merchant, with perishable merchandise to sell to the public. He has a picture for only a few days, and therefore he must get as much as he can out of it within those few days.

"I want a manager who knows how to feel the pulse of his clientele as to likes and dislikes regarding stars and types of pictures. He should be able to select the angles best suited for advertising each picture to this clientele, and if the right angle does not appear from the press book, he must be able to use his own originality.

Interest in Civic Affairs

"I want a manager who is a good mixer. He must not only be courteous and friendly with his patrons, but he should be able to mix with his fellow merchants, with civic leaders, with the clergy and with the school board and the politicians—without being a politician himself.

"I want a manager who is a good housekeeper. He must check his marquee and his lobby to see that the proper photographs are displayed on his coming attractions. He must personally inspect the cleaning of his theatre, and make certain that the screen curtain is closed, that the janitors do not turn on all the lights while cleaning the auditorium, and that the rest rooms are clean and sanitary. He must inspect his carpets and seats, and see that they are repaired immediately when necessary. He must check his heating or ventilating system so that his patrons will be comfortable at all times.

"I want a manager who will be respected by his employees and by his clientele—the type of man to whom the public entrusts the care of children for entertainment. He must cater to the children, for the child patron of today is the adult patron of tomorrow.

Importance of Projection Equipment

"I want a manager who realizes that the heart of his theatre is in the projection booth, and that he is driving patrons from his theatre if his equipment is not functioning perfectly. He must take the time to go over the equipment with the operator at least once a week, so that repairs can be made and worn out equipment replaced.

"I want a manager who writes his ads long before the newspaper deadline, and who reads the proof before the ad is run.

"I want a manager who, if he does not preview his show, at least sees the entire first performance. If he finds any subject in a feature, trailer or news reel that he believes objectionable to his clientele, he will take this subject out of the picture.

"I want a manager who will not be afraid to write our central booker if he believes the wrong picture has been booked for a day on which his community is having some particular celebration.

"I want a manager who will personally edit his show and arrange his schedule within the hours prescribed by the main office, and not allow this duty to fall to the operators or janitors. Nor will he wait until show time to ascertain if the right films have arrived.

"I want a manager who will police his theatre and maintain order during every performance.

"I want a manager who is as much interested in the theatre and its financial welfare as though it were his own.

Good Future for Right Men

"Maybe I am expecting a lot of a manager, but on the other hand, I have a great deal to offer in return to a man with those qualifications. We promote our managers to city managers, our city managers to district managers, and our district managers to the home office. The young manager of today has an excellent future before him if he sincerely tries to learn our business."

I thought the ideas of this theatre execu-

tive were worth passing on. If you are one of the many hundreds of new managers, I am confident that you will find some helpful information that will place you in a position to be more valuable to the company for whom you work. I am just as sure that the added effort and conscientious operation of your theatre will not only be beneficial to you, but will not be overlooked by your employer.

"I hear that your manager died yesterday—I'd like to take his place."
"It's all right with me, if you can arrange it with the undertaker."

Theatre Employees

How A Large Chain Trains Its Personnel

By C. HARRY SCHREIBER

Assistant Western Division Manager, R-K-O Theatres

Here at R-K-O we have endeavored in every way to solve the problem brought about by the shortage in trained theatre personnel.

By means of careful training along well established and sensible regulations, we do believe that we have continued to please our patrons.

Let us take the Palace Theatre in Chicago as an example. Here we have a combination staff of boys and girls. While much has been said, pro and con, on the subject of women in the theatre, we can only remark that on the whole we have

Usherettes at their posts in the R-K-O Palace Theatre, Chicago

found our girl employees satisfactory in every respect.

Before discussing the subject in further detail, I should like to point out that the Palace is one of a chain of more than one hundred theatres. While I appreciate that all of the rules and regulations of a large metropolitan theatre do not apply to the smaller house, I do believe that at least some of our principles of training may be applied in a modified form to any type of theatre.

One fact that we stress to every R-K-O employee is that his job is to make things as pleasant as possible for our patrons. At the same time, we try to make things as pleasant as possible for our employees. The relationship between employer and employee should be based on fair treatment and loyalty, and their mutual cooperation is vital to good operation.

Chief of Service and a group of usherettes at the R-K-O Palace Theatre, Chicago

The Doorman

The theatre doorman is a most important employee, for his duties go farther than just receiving tickets. His appearance and personality mean ever so much to the patron, because his greeting must convey sincerity and friendliness to the patron. He must know at all times the information per-

taining to the schedule of shows, as well as becoming reasonably familiar with coming attractions and their dates.

The doorman must keep in mind as to whether the manager and other executives are in or out of the theatre. His ability to recognize executives and employees of the theatre is of great importance—and his ability to recognize as many of the patrons as possible is of even greater importance. Service of this type is always effective.

The doorman's position is one of trust and responsibility

As the doorman is one of the most trusted employees of the service department, he should possess good judgment in matters pertaining to wrong doing and dishonesty.

Ushers and Usherettes

An usher or usherette should be unfailingly polite to the patrons of the theatre. The same politeness should be extended to their fellow workers, addressing them as "Mister" or "Miss," and never by calling out first names or snapping of fingers.

Whenever it is necessary to approach a patron, the conversation should begin on the part of the usher with a "Pardon me," and end with a "Thank you." If by chance a member of the service staff should accidentally bump into a patron, he should always remember that the patron is a guest, and never fail to apologize.

There are a number of opportunities that present themselves to render service of this kind, and the good usher or usherette will not fail to take them to good advantage. From what one hears, there has been more or less of a letdown in theatre courtesy. If the manager demands that there be no let-

The patron should be greeted with affable courtesy

down in courtesy in his theatre, he may be sure that by so doing, an everlasting impression will be made on his patrons.

Knowing the layout of the theatre is a "must" of the R-K-O Service. Every member of the service staff is made to familiarize himself with the theatre proper, such as the location of telephone booths, lounge rooms, drinking fountains and the offices of executives. The knowledge of this information enables him to return intelligent answers to a patron, and makes that patron feel welcome in your theatre.

The conduct of an usher or an usherette should always be that of a gentleman or a lady. Discipline and training are essential at all times if the members of the service staff are to coordinate properly, as all rules of conduct have definite reasons, and must be respected and obeyed while on duty. Instructions should be carried out promptly and without argument, as any differences may always be discussed and settled privately.

It is our policy—and, we trust, the policy of most theatres—to employ persons of such calibre that their actions away from the theatre will not reflect unfavorably upon the reputation of their theatre. The ushers or usherettes should know how to conduct themselves in their dressing rooms in a proper manner, and not engage in any loud or disturbing talking. The dressing rooms should always be kept as clean and orderly as possible.

Accidents and Complaints

A member of the service staff, apart from the Chief of Service or the Assistant Chief, should not attempt to handle any accident, regardless of how minor it may be, without the assistance of a superior. If an accident occurs in his vicinity, he should of course give the injured person every immediate attention, paying particular regard to the condition of the patron. A superior may then be summoned to take any further steps that may be necessary. In our own organization we demand that a full report be made out for even the most trivial of accidents on forms provided by our Insurance Department.

All complaints, even when apparently unreasonable, should be handled without giving offense to the patron. An executive or immediate superior should be called if the usher or usherette is unable to dispose of the complaint satisfactorily. This definitely applies to patrons requesting refunds.

Seating patrons with a smile

Every member of the service department should make all possible efforts to try and locate any lost article reported by a patron. If he is unable to locate the article at the time, he should take the name and address of the patron, along with a description of the article lost, and ask the patron kindly to call back the following day. Before going

off duty, he should turn in a report giving a description of the article and the location where it was lost to the Chief of Service, so that he in turn may notify the janitors to make a further search. No greater impression can be given to a patron than by returning something of value which may have been lost in your theatre.

Exceptional Opportunity

In my opinion, there are greater opportunities today for the newcomer in the theatre field than ever before.

There are a great many men and girls entering the theatre field who are keenly interested in their work and sincerely anxious to make good. They realize that the patron appreciates courtesy and comfort, and in endeavoring to render the best service possible, they are making friends for the theatre.

Needless to say, theatre executives and managers are constantly on the alert for this type of employee. If the new employee displays a real effort to make good, he may not only be sure of his position, but will stand in line for rapid promotion. With many new theatres to be built and a possible reshuffling of personnel, the opportunities for advancement in theatre business are virtually unlimited.

"But isn't there someone already sitting in that seat?"
"Oh, it's just a sailor. He won't mind."

A Word to the Usher

Some Tips for Advancement in Theatre Work

By CHARLES H. RYAN

I often feel that there are certain questions which every young man or every young woman in theatre work should ask himself or herself.

Who's who in your organization? Who is an outstanding figure in your theatre or department? Who is looked upon as a leader willing to accept responsibility? Who has initiative, aggressiveness and responsibility? Who has accomplishment? What individual is possessed of the best ideas and who among you is promoting ideas for the betterment of the organization with which you are identified.

If you are looking for something to turn up that will be advantageous to you, the chances are you will live and die a disappointed man. Opportunities seldom if ever turn up to your advantage without a justification upon your part which has been caused by the weighing of your value by the organization with which you are connected.

You, by your own efforts, can make yourself so valuable that your organization cannot afford to dispense with your services. You will be given greater responsibilities, more authority, and be made supervisor over a number of other individuals.

You cannot go further than your organization goes. You cannot succeed to a greater extent than your employer does. If your employer or perhaps the theatre with which you are connected isn't making progress, make it your responsibility to ascertain to what extent you are responsible. If you are ambitious, if you are earnest, be something more than a social security number on the payroll. You can make yourself conspicuous by excellent work, by pounding and driving ahead on your job every day.

Service to the Public

Service to the public, to those who spend their money for food, or clothing, or amusement, is one sure way to make any kind of business establishment safe from the assault of competition.

Many big commercial institutions have long recognized the full value of cheerful, smiling service—of giving even more than the money expended calls for. Here in our own organization our employees make a voluntary pledge to uphold our standards, and to follow our established rules of good will and service. The pledge to which I refer is as follows:

I will to the best of my ability, try:

To be a gentleman.

To render 100% service.

To be courteous to patrons and to fellow employees.

To work willingly and cheerfully.

To be pleasant and wear a smile.

To be alert, to anticipate patron's desires and to surprise them with services and attentions they do not expect.

To speak pleasantly; to say, "Yes, sir," and "No, sir," and "I thank you," and "Please," in a pleasant

voice.

To obey our rules because I realize that rules are necessary in a business organization.

To practice headwork and heart-work because I know that these virtues are indispensable to success.

To keep my temper.

To avoid arguing with a patron.

To make every patron satisfied and happy.

Rules for Good Will

1. Be neat. Be on time. Do not talk loud. Do not chew gum.
2. Be dignified. Avoid unnecessary conversations.
3. Do not encourage flirtations with patrons.
4. Never give short or flippant answers.
5. Avoid listlessness. Stand erect at your post.
6. Keep cool. Do not lose your temper.
7. Never argue. When anything is beyond you, refer to your superior.
8. Maintain quiet during the performance.
9. Make a special effort to comfort

Mr. Charles H. Ryan (seated), shown with Mr. Eli Arkin, manager, and Mr. Walter Stacey, assistant manager, of Warner Bros. Avalon Theatre, Chicago

elderly people.

10. Report anyone changing seats more than once during the performance.
11. Never be discourteous. Grouchy people can't stand up under kindness.
12. Always meet rudeness with tact and kindness.
13. Don't grouch . . . we sell good service just as we do good pictures.

be asked to step to the foyer until the baby becomes quiet.

19. You, by your conduct, can make or break this theatre. It may take a hundred dollars worth of advertising to coax a new patron into this theatre, and you, with surly manner or sulky word, can drive them away, never to return.

Staff of ushers at Avalon Theatre, Chicago

14. Always wear a cheerful smile.
15. Strive to please and satisfy every patron as if you owned the theatre yourself.
16. Do not say, "Yes," and "No," but "Yes, sir," and "No, sir," or "ma'am" as the case may be.
17. "This way please" . . . "Thank you" . . . "Kindly remove your arm please," are magic phrases. Always use them when speaking to patrons.
18. Mothers with crying babies should

Courtesy Our Creed

We believe in courtesy, in generosity, in good cheer and in friendship. But most of all—we believe in COURTESY.

Therefore, it behooves every man or woman we employ to remember this always, and to treat all patrons with COURTESY and careful consideration.

Impress upon the patron, through your COURTESY, the fine good fellowship of the place; the "no-trouble-to-help-you" spirit. Never be grouchy, surly or impa-

tient—remember, the patron pays your salary; without him your salary stops, and you are out of a job.

Keep Customers Coming

New customers are just as valuable as old customers—remember that; for each new customer is an old customer in the making. See that you do your part to make him want to come back with his family and his friends. Impress upon him through your courtesy the fine good-fellowship of the place; the "no-trouble-to-help-you" spirit.

"That must be a good theatre, because the employees are always so kind and courteous."

Kindness, if you show it to others, will radiate from you like the warmth of the sun over the hill-tops. Kindness and courtesy are infectious. Give a cheerful, kind and courteous answer to the meanest grouch (if there is such a person), and you are quite sure to have a kind answer in return. A grouchy person can't stand up under kindness and courtesy.

"Give, and it shall be given unto you—full measure, pressed down and overflowing." And that goes for a surly answer as well as a courteous one.

Among the things the usher should have knowledge of is the schedule of the show. He should know the length of the show so that he can answer the frequently asked question, "If I go in now, what time will I be out?" The usher should be able to tell the patron whether or not the feature is nearly over so that he can suggest that the patron wait in the lounge.

You young men and women are in exactly the right environment to acquire not only the fundamentals of show business, but also to broaden out into other fields if you so desire. You have constant contact with the public, which affords valuable experience, and by initiative, observation and strict application you will develop a technique which it would otherwise be rather difficult to acquire.

Executives are always on the lookout for the young man who has really got what it takes, and that young man can be you if you are constantly on your toes.

The live-wire usher who uses every means to learn the rudiments of theatre operation, in every department, is the usher who will get somewhere.

Knowing the Ropes

Ropes have become part of the equipment in use around theatres, in lobby and inside to hold people clear of all aisles and exits. Everybody on the staff must be particularly cheerful when the house is full and people are standing in rear and in lobby. The staff should wear a broad smile, thus helping to create good will, and they should say pleasant things to those standing; for instance, "It won't be long now," or jokingly saying, "Only a few hours more." In this way you can hold your patrons.

"Stand inside the ropes, please; thank you," is a term suitable for this kind of work.

Never speak crossly to any patron any time—but particularly in a crowd. The reason for this is that too many people hear you and take sides . . . not with you, but with the patron.

Never pull ropes roughly around patron or patrons. Just simply say, "Step in a little further, please," or, "Sorry, sir (or madam or miss), but will you please move up?"

Never accept tips—NEVER.

Aisles and exits should always be clear for your own and customers' protection. You will find people willing to co-operate with you on this. The law insists on it, too, and rightly.

The return of a lost glove, cap, hat, umbrella, pocketbook or anything, in fact, makes friends.

Ushers should be ready to hold coats of both ladies and gentlemen patrons when they are ready to leave.

Let the public know you are with them and want their business.

ADVERTISING AND PROMOTION

Advertising, Exploitation—and Showmanship

By M. H. NEWMAN

Director of Exploitation, Western Division, Columbia Pictures Corp.

(As the result of a request to Mr. Newman for a few biographical facts, we were rewarded with the following unblushing autobiography entitled "My Biography—and Who Cares?")

"Just ten years after Mrs. O'Leary's cow kicked the bucket, another great catastrophe befell Chicago . . . I was born there . . .

"My first sixteen years were rigorously devoted to training for the life of a showman . . . I did absolutely nothing but eat, sleep and faithfully study the racing form . . .

"At sixteen I stowed away on an ocean liner going to Germany . . . In shipboard I particularly distinguished myself by setting the world's all-time K. P. record . . . I peeled more damn potatoes than you can find in Idaho today . . . Upon docking, I became the first American to tour Europe without benefit of passport, visas, money or luggage . . .

"In Manila I met a wonderful character who had two obsessions . . . theatres (which he owned) . . . and craps (which he always lost) . . . First I went to work for him, managing his chain of theatres . . . Then I went to work on him, taking him for 250 pesos in a crap game, with which I promptly went into business for myself . . . roadshowing two-reel Chaplins, 'Tillie's Punctured Romance' and 'The Hypocrites' throughout China.

"Then came the Revolution . . . Joining Dr. Sun Yat Sen's Chinese Army as a colonel, I soon worked myself up . . . Three months later, I was worth (to the enemy, there was a price on my head) fifty

"Mike" Newman

thousand li . . . which in American money is about a buck and a quarter . . .

"Returning to the United States, I met Sid Grauman and became his General Manager . . . Three years later, the late 'Uncle' Carl Laemmle talked Dutch to me . . . and I took over the management of his Universal theatres.

"I am now associated with Columbia Pictures as the Director of Exploitation, Western Division . . . When I took the job fifteen years ago, they told me it was temporary . . . It probably still is!"

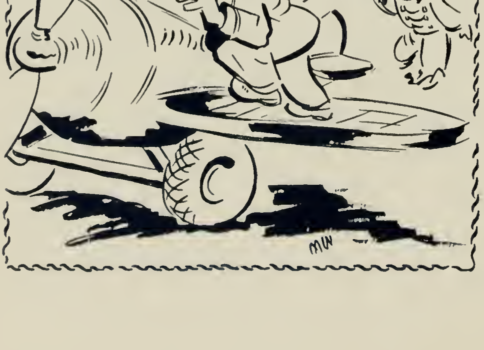
You have asked that I write a short piece on advertising, exploitation and showmanship.

Somehow, this reminds me of another one some thirty years ago at the other end of the world.

I was in China then, helping the late and beloved Doctor Sun Yat Sen liberate his great country which, once again, is fighting for its life.

I had organized and helped train China's first air forces. My aviators were all young patriots. One night my rickshaw boy approached me hesitantly at the landing field.

"Colonel," he asked in pidgen English, "Would you teach me how to fly?"



"Sure, sure," I replied, "but not tonight. We take off in ten minutes."

The boy wavered for the barest second. "But couldn't you," he protested softly, "teach me in ten minutes?"

Believe me, your request is simpler.

I can tell you all about showmanship—as it exists today—in ten words, not ten minutes.

Hitler and the Box Office

For the simple truth is—there is no showmanship today.

Unless, of course, you want to call Hitler a showman.

For it was he—not showmanship—who was filling every theatre in the country; filling them with heartsick people desperately seeking an hour's escape from the holocaust in which he had plunged the world.

It was Hitler and Tojo—not showmanship—trying to steal their "living room," who were responsible for "standing room only" in every theatre in America.

Let's give the devils their due. They—not showmanship—created the greatest box office boom in the history of motion pictures.

But, of course, they aren't around any longer. Neither will those lines be at our theatres. That is, unless we have a revival of good old fashioned showmanship.

What do I mean? Well, let's turn a page or two in my scrap book of memory.

Modern Adam Still Seeks

The year is 1920.

Sid Grauman has just booked a picture called "Adam's Rib" into his Rialto Theatre in Los Angeles.

From the reports all over the country Grauman hears the picture is "dying" at the box offices. Grauman is determined, however, to put it over. What does he use? Why, showmanship, of course.

Two weeks before the picture opens, thousands of startled Angelenos awoke one

morning to find a bleached rib-bone in their mail boxes, with a red tab attached on which is printed, "Beware—Adam's Rib."

A week later, a skeleton-like apparition interrupts a concert at the world-famous Hollywood Bowl. It floats over the audience and wails eerily.

"I am Adam. I am looking for my lost rib."

The next week, thousands of people jammed the Rialto Theatre to help the ghost of the Hollywood Bowl look for his "lost rib."

The picture played for eight phenomenal weeks at Grauman's Rialto.

What put it over? Showmanship, of course.

A Tale of the Great Drought

Here is another example:

This one's on me. I was operating the Columbia Theatre in Seattle during prohibition. Against the judgment of my well-intentioned friends, I booked a picture called "Wine." I knew I could sell it. And sell it I did, with one stunt.

I had two hundred boxes made up with the word "Wine" burned into the wood. These I loaded onto a horse-drawn wagon, roped and covered them with a tarpaulin, and engaged a driver to drive the load to the outskirts of the city.

There, by pre-arrangement, he removed a wheel to give the effect of being stalled, carelessly pulled back a portion of the canvas, exposing a part of the load—and disappeared.

A few minutes later, the sheriff's office received a call from an apparently irate woman. Indignantly, she directed them to the contraband wagon.

They promptly appeared on the scene, confiscated the wagon, and the morning paper went into a journalistic orgy about uncovering the city's "greatest illegal cache."

A short time after the bulldog edition appeared on the streets, I called the sheriff. Identifying myself, I demanded to know why the wagon had been seized. I explained the boxes (empty, of course) had been destined for my theatre as a lobby display.

When the opposition afternoon paper discovered the hoax, they romped all over their front page jibing the morning sheet and reprinting the picture of the wagon load of empty boxes labelled "Wine." This

time the picture showed the load with all the tarpaulin taken off.

Result: Standing room only during the engagement of six weeks.

Screeno or Showmanship

These are pages from yesteryear. That was showmanship.

I could go on at length reminiscing, recalling the legendary exploits of master showmen such as the late Harry Reichenbach, but I'm sure you get the point.

Today, all an exhibitor has to do to be a showman is to open his doors and get the H—— out of the way.

This, we know, can't last.

A short time ago, these same exhibitors were frantically trying to lure people into their empty theatres with Bank Nites, Dishes and Screeno.

Who knows, maybe in the very near future, we may again have to face the decision:

Screeno or showmanship?

But I hope we don't. If we do, I hope this time the industry reverts back to good old showmanship.

THEATRE ACCOUNTING

That Depreciation Item

How and Why It Concerns You

By JOHN BULLERS

Many of our best theatres and theatre chains have set up a depreciation fund. There must be a good reason for such a fund, and there is—several of them, in fact.

The depreciation fund serves a useful purpose both in the present and in the future. Let us look first at the future, for that is where most of us have our gaze directed today.

First of all, one must set up a proper period of depreciation. This may be done on the basis of a good depreciation table and on one's own experience, as well as by consulting the manufacturer and the theatre supply dealer. If we find, for instance, that a certain piece of theatre equipment has a normal life expectancy of ten years, we simply allocate ten percent of its cost for each year.

I am not trying to give you an elementary lesson in depreciation. What I am trying to point out is that at the end of ten years your piece of equipment will probably be worn out and must be replaced. Now, during those intervening ten years you will have had some cycles of good business and some of bad business. Suppose you have set aside no funds for depreciation, and at the end of those ten years you find that times are pretty tough. The result may well be that you cannot afford new equipment and so must attempt to patch up what you have. When this happens, your picture presentation suffers, and your patrons begin to

walk one block or several blocks further to the next house when they want to go to the movies.

Suppose, on the other hand, you have been farsighted enough to set up a depreciation fund, and every year have set aside the proper percentage for each piece of equipment in your theatre. Then, when something wears out, you have the money on hand to purchase new equipment. This wise provision for the future is simply good business, and helps to explain why some theatres prove a good investment and others go broke.

Deductions on Income Tax

The other main reason for watching depreciation is the income tax. The income tax laws, in spite of the fact that they may be confusing to a great many persons, are very specific in what is to be taxed and what is exempted. Countless men and women pay more income tax than they should because they do not understand the deductions to which they are entitled. There is nothing illegal or unpatriotic in taking all of the deductions to which you have a just claim. The government says that you have every right to do so, and the income tax man will not come chasing after you at a later date.

One of these legal deductions is depreciation on equipment. When a shrewd business man calculates his annual income taxes, he deducts from his profits an amount equal to the annual depreciation of the equipment installed in his place of business.

Strangely enough, some theatre owners have failed to make this legal charge against their gross profits, and consequently have been paying more taxes than they should have. Unquestionably, such exhibitors should consult their accountants so that this important deduction may be made on their next tax return.

To assist theatre owners in determining what percentage of the cost of their theatre equipment may be charged off annually, we are publishing a list of theatre equipment and supplies, indicating the years of life which may reasonably be expected from each item. For example, a sound system should be good for ten years of use, so that one-tenth of the original cost of the sound system may be deducted from the gross profits each year over a period of ten years.

Property Depreciation Tables

The following figures show the average useful life in years of nearly all items of theatre equipment and supplies. They are compiled from information received from reliable sources, and may be safely used for depreciation reserve fund purposes and for income tax deductions.

I. Theatre Equipment

Cabinets—record and film	15
Carpets	8
Choppers, ticket	10
Counterweight systems	20
Counting machines	10
Curtains:	
Asbestos or steel	33
Machine automatic	20
Stage	8
Decorations, painted mural, etc.	12
Dimmers, stage and studio	8
Draperies	8
Elevators	20
Fans, exhaust and ventilating	15
Furniture, lobby and foyer	15
Lights, stage, Kleig, etc.	20
Linoleum and rubber flooring	10
Mats, rubber and linoleum	10
Mirrors	20
Phone system interhouse	10
Projectors:	
Slide	15
Motion picture	10
Registers, ticket	10
Rewinders, film	15
Scenery, stage	3
Seats	20

Signal systems	15
Splicers, film	15
Sound equipment	10
Stereopticons	15
Generators	15

II. Building and Equipment

Air conditioning systems:	
Large—over 20 tons	20
Medium—5 to 15 tons	15
Small—under 5 tons	10
Ammeters	15
Clocks	15
Compressors, air and vacuum	20
Electric clock systems	20
Fire equipment	25
Heaters, electric	10
Heaters, gas	15
Heating systems:	
Boilers and furnaces	20
Burner equipment	
Gas	16
Oil	10
Radiators	25
Lighting systems:	
Wiring	20
Fixtures	15
Miscellaneous facilities:	
Awnings	5
Doors, louvre, ventilating	15
Incinerators	14
Screens, windows	10
Shades	5
Venetian blinds	8
Plumbing:	
Faucets, flushing valves	15
Fixtures	25
Pipes	25
Valves	20
Pumps	13
Roofs:	
Asbestos	25
Asphalt and tar, prepared	15
Galvanized iron—	
Light or cold dipped	15
Heavy or hot dipped	20
Tar and gravel, 5 ply	20
Tarred felt	10
Starters, electric	20
Switchboards, electric	25
Telephone equipment	20
Tools, small, miscellaneous	5
Transformers	25

III. Office Equipment

Adding machines	10
Addressing, mailing machines	15
Binder,loose-leaf	20
Cabinets and files	15
Calculators	10
Call system and annunciators	14
Chairs, heavy	10
Check writers	8
Cleaners, electric vacuum	6
Clocks, time	15
Coolers, water	10
Desks	20
Dictation machines	6
Duplicating machines	10
Fans, electric	10
Lamps, desk and floor	10
Linoleum	10
Lockers	25
Mirrors	20
Racks and stands	15
Rugs, carpets and mats	10
Safes and vaults	50
Shades, window	10
Signs, board	10
Typewriters	5

Theatre Seating

Beauty and Comfort in Modern Chairs

By B. F. SHEARER
President, B. F. Shearer Company

Good seating, like good projection and good sound, is one of the three imperatives for the successful operation of any theatre. These major items have come to be looked upon as a group almost inseparable in their importance.

In this article we will talk about chairs and their relative importance to any theatre.

The public attends the theatre for relaxation, and it certainly cannot relax by sitting in an incorrectly engineered and poorly constructed theatre chair.

Well constructed and comfortable theatre chairs

What Makes for Comfort

Let us consider what must be attained to have real comfort in a theatre chair Each part must in itself be carefully and properly constructed in accordance with a design which is correct in the first place. The use of springs or rubber and fine fillers in the seats and backs contribute to a large extent in gaining softness and support. No less important is the relationship of the back to the seat to attain correct sitting posture. The seat must be the proper height from the floor and the proper pitch, taking into consideration the incline of the floor.

Seating engineers are constantly considering these varying conditions when they begin the layout or preliminary on any job of chairs preceding manufacture.

Most reputable seating manufacturers have seating lay-out engineers who are qualified in making layouts to take advantage of all seating space and have each chair placed in a perfect sight line. They will also arrange the seating plan so that the chairs will be uniform in measurement from back to back; as well as width of cushions. They will give you the correct pitch for the floor for your particular auditorium. Installation of chairs is also an important item, and when done properly the chairs will remain tight for years. In these days of double features, chairs more than ever add or detract from the seating comfort of your patrons.

Semicircular seating arrangement in the huge Music Hall of Purdue University

Design and Appearance

Next in importance is design and appearance. When one compares the chairs of years ago with the last models made, it reminds one of the change that occurred over the same era in the automotive industry.

Nearly all of the principal manufacturers of theatre seating produced one or more new models of chairs after the war. In most cases these new models exhibited some rather striking developments in de-

sign and construction.

Perhaps the most significant factor was that of seats which largely eliminated the inconvenience both to the person trying to reach or leave a center seat and to those persons who were seated. With certain models it is possible to remain seated, while in other types, the seat inclines upward, and resumes its normal position automatically when the person seats himself.

Many types of new chairs provide for the seat being automatically raised when the chair is unoccupied. This feature affords easier access between the rows of seats, lessens fire hazards, and simplifies the work of the cleaning staff.

There has been considerable study of normal seating postures, and most of the newer models offer an improved design intended to afford a greater degree of comfort to the patron.

Fabrics available for upholstering chairs are unbelievably improved, particularly from the standpoint of wearing quality.

The designers of these materials have most interesting developments to enhance the eye appeal of the fabrics.

Seating arrangement of the Bard Theatre, Louisville, Ky.

Improved Construction

Not only is the chair manufacturer taking advantage of the many new coverings, but much has been done regarding other component parts of the chair. New metals and design of hinges, constructed for longer wear and trouble free operation; new spring wire that will add to the resiliency of the cushion; as well as new synthetic rubber. Cotton, palm fibre and sisal have all been improved through government research.

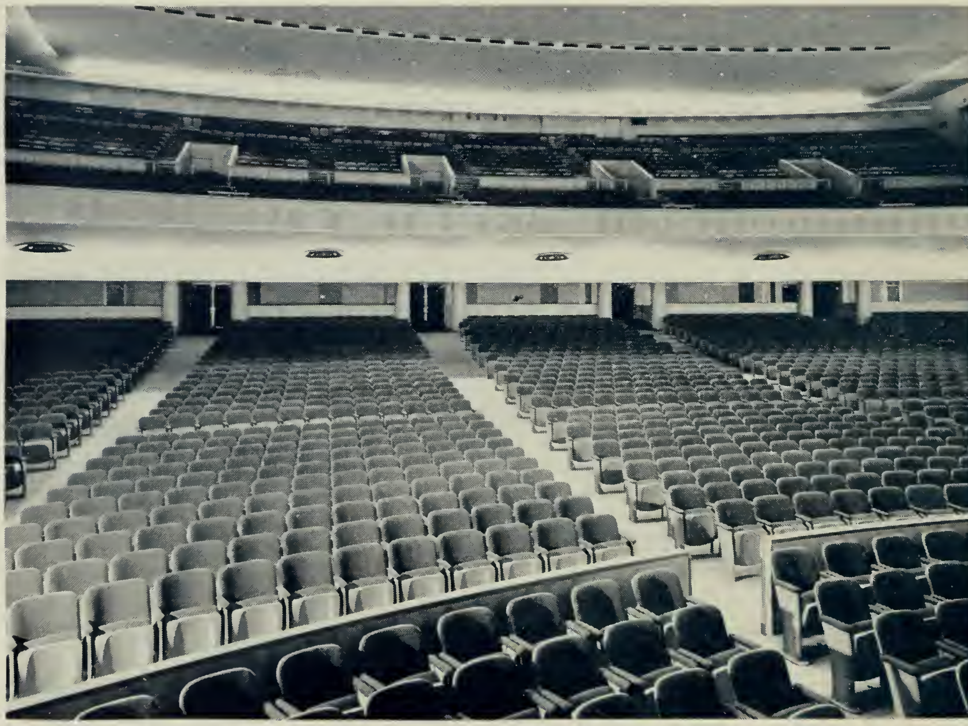
The two high points in theatre chair construction so far considered have been comfort and beauty. Neither of these attributes

would mean very much, however, without durability. Theatre chairs are not replaced every two or three years, but are bought to give many years of service. The mechanical construction and performance of the chairs, as well as the use of good materials, determine the length of the period of service that a chair may be expected to give.

Theatre seating also plays a large part in auditorium acoustics. Heavily upholstered chairs have, in a large measure, the same absorptive qualities as if the chairs were occupied. If a theatre has a small audience, the sound therefore will be practically the same as if the theatre were full. Velour, mohair and soft fabrics have of course more absorptive qualities than hard wood or leather coverings.

Know Your Source of Supply

Your theatre equipment dealer has samples of construction and fabrics, as well as a manufacturing knowledge of theatre chairs, and will be in a position to solve your seating problems. We suggest that you talk over problems with your theatre equipment dealer from time to time.



The Kleinhans Music Hall in Buffalo, N. Y.

Theatre Carpet

And How to Choose It

By GERALD F. McGIMSEY

Manager, Contract Carpet Division, A. & M. Karagheusian, Inc.

What are the points to look for in choosing theatre carpet?

First, there is the question of fabric.

Remember that every quality of carpet is created to give a particular kind of service. It is for you to decide which type of service you want to buy.

It is important to realize this, because many buyers in making their choice see nothing but the initial price. It is only when you know the service a fabric gives over the years that you can judge whether you are making the best buy. In a sense, the real cost of a carpet is not apparent until the end of its service—then you know positively its cost-per-year, and the quality of its appearance. As you cannot wait that long to judge, the next best thing is to be guided by the experts of an experienced and reputable establishment.

Types of Weaves

You will probably choose your carpet from the four types of weaves generally supplied for theatre use: Wilton, Velvet Broadloom, Axminster and Printed Velvet. Briefly, they have the following characteristics:

Wilton Carpets. Very firmly and compactly woven, with "hidden yarns" below the surface that give it great durability. Wilton weaves retain their fresh appearance evenly throughout their life. The pattern

A Wilton tone-on-tones—Mayfair Theatre, Ventura, California

stands out with especial clearness and precision. Qualities may vary from medium to ultra-heavy. The Wilton weave is usually selected by the better houses. Measured by cost-per-year standards, it is often cheaper in the long run than lower priced weaves.

Velvet Broadlooms. Similar construction to Wiltons, but without the "hidden yarns." Velvet Broadloom is the weave in which most plain shade carpets are made. You find them usually in neighborhood houses that want to provide an intimate atmosphere.

Figured Velvet Carpets. These may be either stenciled or drum-printed. In the first case, the pattern is printed directly on a plain fabric. This type is not often seen in theatres. In the second, the colors are applied to the yarns on a large drum, then woven. Owing to this fact, you do not find the precision of pattern outline, nor the deep rich glowing colors which you get in Wiltons or Axminsters, where the yarns are immersed in the dye. If the quality of appearance is less important, you may find this type of fabric not without merit. It is often found in less expensive houses.

Axminster Weaves. This weave permits a large variety of colors in the design. Its heavier grades give excellent performance. It is also sometimes used in less expensive grades, which give good service

A Wilton weave in a pattern that is colorful and striking, yet in perfect good taste —the Hawaii Theatre, Los Angeles, Calif.

where traffic is not too heavy. One of its handicaps is that it is not as suitable as Wiltons or Velvet Broadlooms on stairways. Generally speaking, Axminsters are not extensively used in theatre work.

In considering fabric, it is important to remember that no carpet can be better than the wool it is made of. As a layman, you may not be able to judge quality of the wool itself, but if you buy from one of the leading manufacturers, you can depend on their blend of wool having been decided on as the result of a long experience which they stand back of. Each type of wool has its own features. Some are famous for "burst," the capacity for coverage—some for lustre—some for their sheer ability to take punishment. To combine these so as to get the finest results is the aim of the manufacturer who takes a pride in his merchandise.

Style Creates Atmosphere

Next to fabric comes the question of style. More than ever, theatre owners are conscious of the fact that a theatre stands out by reason of its own particular atmosphere. When the same film can be booked by a number of houses, the feature which will bring in the public is the charm of the establishment. In this respect, the carpeting has a very important contribution to make. It is one of the most important elements in the decorative scheme.

The Main Street Playhouse, Kew Gardens, L. I., N. Y., in which the carpet forms the most important decorative area, and achieves an intimate yet rich effect.

Your supply house, which specializes in theatre carpet, can offer you a wide range of handsome designs. More than that, it can recolor any one of them to suit your particular scheme of decoration. And even more than that—if the yardage warrants, it will prepare for you a special design to give your theatre an exclusive character.

What is the style trend of today? Gen-

The world's largest theatre, Radio City Music Hall of New York City, is particularly proud of its carpet—a high pile Wilton.

erally speaking, carpet for a theatre leans toward fantasy. Twenty years ago this found expression in designs that were as loud as a brass band. Demand called for large motifs with sharply contrasted bold colors. Today, while not forgetting the importance of creating a dramatic atmosphere, quieter effects are in vogue. The

sharp black lines which occurred so frequently in the old theatre carpets have given way to softer colors in tone. There is a greater refinement in the juxtaposition of the colors themselves.

In some cases, there are signs of an even more subdued type of carpeting. As the neighborhood theatres have grown in number, they have developed a character of their own. They no longer seek to compete with the spectacular interiors of the super-theatres. They aim at an atmosphere that is more intimate, sometimes suggesting a wealthy private home. It is here that you will find tone-on-tone patterns, and even plain shade broadlooms. The object is to make people feel cosy and relaxed rather than overwhelmed by circus effects.

Just what direction theatre decoration will take remains to be seen. New developments are forecast in the field of lighting, and these will no doubt have their influence on the type of carpet that is called for. Walls and textures are likely to be more plain, and the lighting will be designed to bring out its own beauty and certain accented areas.

The Community Theatre, Morristown, N. J., has chosen a Plain Shade Broadloom, creating a restrained atmosphere like that of a wealthy country home

DRAPERIES

Dress Up With Draperies

They Make for Attractive Theatres

It is surprising to find the great improvement that may be made at very nominal cost, simply by the installation of a few draperies. There is nothing that can change the general appearance of a theatre and brighten it up more than draperies.

There is much to be said on how to buy draperies—we can only touch on the high spots here, and give a few suggestions that we have learned in the course of our long experience.

Three Types of Draperies

There are three distinct types of theatre draperies: for house, wall and stage use.

House draperies consist of—box office drapes; the entrance doors, which are usually glass panels; the aisle entries; standee rails; the restroom entrances and windows; the exits and the wing walls. House draperies in general are made of velours, damasks, monk's cloth and repp, while for glass panel doors we use casement cloths, satins or other lightweight unlined material. House draperies may be either of cotton or rayon velour. Heavy damasks and tapestries are also used to some extent, but as a rule, cotton velour in most cases should be favored. Their wearing qualities are better than rayon, and this fact is important, since draperies are used or handled a great deal. Of course, rayon type velours are much more decorative, due to their high lustre or sheen. Either of the velours, when made with the proper fullness and lined, are most satisfactory.

Care should be taken in selecting house drapes as to color, design and quality of materials. Colors must definitely harmonize with the painting and decorative scheme, as well as the carpet. Designing must carry out the lines of the architectural motif—either in straight, festooned, overlap or hard valances—as well as the type of curtain or legs used and the tie-backs.

Standee drapes should be preferably installed on tracks for ease of changing, and in some instances, for keeping out light.

The quality of the house draperies should be selected very carefully. All house drapes —except boxoffice and glass door types— should be lined for serviceability and fading, and should be made with 100 percent fullness for the beauty that the fullness adds. Be sure that the materials selected will dry clean satisfactorily, as house draperies get a maximum of wear.

Wall Draperies

Wall draperies are used in many theatres, either for the complete draping of the

walls, the balcony face, the back wall and around the proscenium opening—or perhaps in panels only on the side walls. These draperies may be made either with from 50 to 100 percent fullness, or stretched with no fullness. They are usually tacked

An attractive employment of house draperies, with festooned valances and legs

at both top and bottom with a small moulding nailed over the tacking, or with installation sound strips.

These wall drapes are generally made of figured damask or a crash material, either of cotton, silk or rayon. Care should be taken when no fullness is employed to avoid a material that has a high reflective surface when stretched, especially at points where reflection may occur.

Wall draperies have many definite advantages. They are decorative, they help the sound, they save painting, and in new construction many times even save plastering as well as painting. In old theatres, wall draperies are easily installed by placing grounds for tacking on the walls where you want the drapes installed.

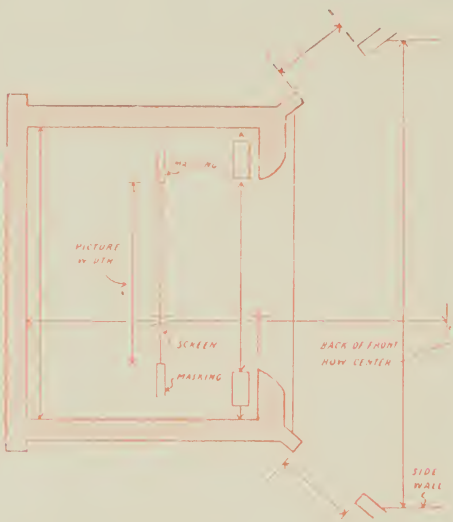
Stage Draperies

In stage draperies, there are two definite ways to treat your stage—although a combination of both may also be employed.

Most theatres want a stage outfitted for the use of pictures only. A few wish the chief emphasis placed on drapes appropri-

ate for stage productions, while others may want their stage arrangements chiefly for pictures, but with some consideration made for small stage productions.

As the picture policy is the most important, we will try to give you some ideas along these lines.



A typical stage plan

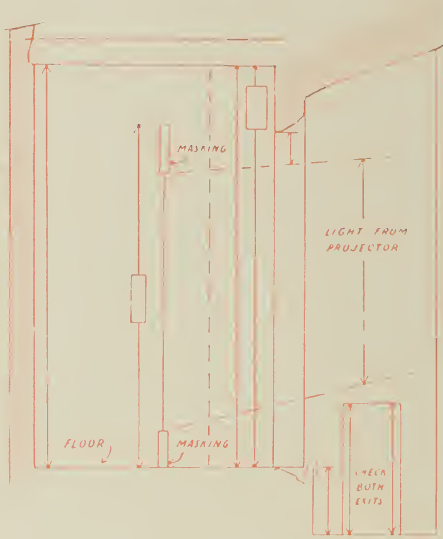
First—the layout, the plan and the elevation are the most important (see drawings). It is necessary that you have enough draperies to fill in or frame your picture presentation, with due regard to side angle seating or disturbing the sight line from the projection room.

No lofts or fly room are provided in a great many of our present theatres, so we are forced to design with only a small amount of space above the proscenium opening or hanging space for draperies.

An Average Stage Set

The average stage set consists mainly of a grand drapery, which is usually an ornamentative festooned or hard fixed first piece at the proscenium opening line, backed up possibly with the same or with a different colored material. Then there are two small decorative legs at the proscenium opening which may come to the floor or drape to the side of the opening. This set is usually made from a highly decorative material in a bright or odd color and in contrast to the balance of the stage, using rayon velours and at times colored braids, ropes and other ornaments. This set is more or less permanently fixed, as it is not moved for either stage or picture presentation.

After the grand drapery, the main or front close-in curtain works as a traveler, and usually is made of a harmonizing color



Section through stage

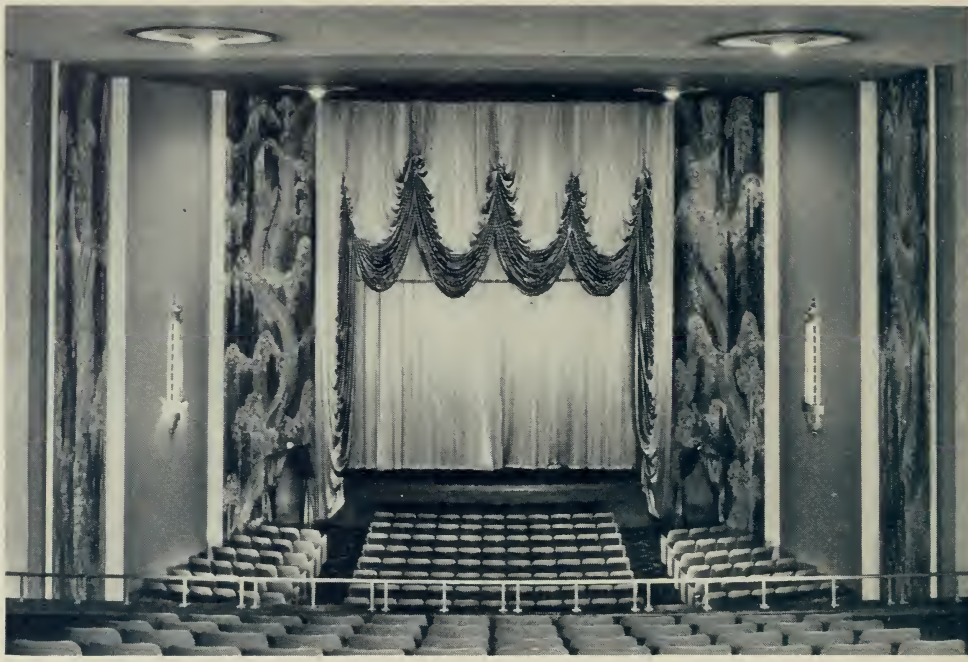
velour to go with the grand drapery. This close-in may even work in back of a pair of legs and the first border, if the stage is deep enough so that announcements may be made from the stage by entering from the first entrance.

In following the close-in, it is necessary to frame the stage, both from the sides of the picture sight angles with legs, and from the top with borders. These angles and

Stage draperies of the Paramount Theatre, Atlanta, Ga., showing proper arrangement and fullness

sizes are determined for the legs from the side wall seats, and for the borders from the front row of seats so as not to interfere with the picture, the legs gradually working in to the picture size in use. Materials used for this set are various—cotton and rayon velours, damasks, repp cloths, tapestries, satins or any material to fit the decorative scheme and the pocketbook. Care should be taken not to select highly reflective or light colored materials too close to the screen, as the focal point is always the screen and nothing must detract from the picture.

After this set, the screen close-in is used, usually immediately in front of the screen,



Stage draperies designed to harmonize with the decorative scheme—State Theatre, Richmond, Ind.

and working as a traveler. It should be made of flashy satin or damask, as this curtain may be used for opening titles and for closings of regular performances.

Fullness Enhances Appearance

With reference to fullness of materials used, as well as linings, this depends entirely on what your budget may allow. The front set should never be less than 100 per cent fullness. Your borders and legs or your Cyc set should have at least 50 percent fullness, if not more, and your close-in should be at least 75 percent in fullness—and looks much better if 100 percent is used. Linings add to the richness of draperies and prolong their life to a great extent.

In screen masking, always try to use a deep black cotton velour, and after you have set the sizes of the masking frame, place the velour just slightly into the picture. This will give the picture a depth that cannot be obtained by using black sateen, or by leaving a slight space between the picture and the masking.

Curtain controls can be used to definite advantage in many theatres on either or both of the close-ins, as they may be operated by push button controls from the projection room.

Draperies can and will give you that extra added dressed up and decorative appearance that cannot be obtained otherwise.

Theatre Signs and Letters

Development of Theatre Billing Equipment

The picture theatre business has come a long way since the days when exhibitors had to also be sign writers. In those early and glamorous days of nickelodeon operation, hand lettered posters of about 3-sheet size were painted in garish colors with profuse decoration. These posters could not be made up until the show was received, which was usually only an hour or so before opening. Poster paper was purchased in rolls and after using enough rolls exhibitors became quite able sign writers.

If the title piece had been lost from the picture it also fell to the exhibitor to concoct a new title, and since he was without benefit of preview or press book his brainchild was sure to fall into the class of gross misrepresentation.

Lithographed one-sheets, three-sheets and six-sheets made their appearance in due time, and various forms of accessories, star photos, 11x14's and stills were employed long before the more spectacular type of billing was adopted. This was probably due to the fact that runs were of too short a duration to invest much money in displays, and once prepared and used they were of no further value. Poster exchanges for used billing were to come.

Titles of current attractions, names of stars and other information pertinent to the pictures consequently could only be ascertained by quite close inspection of the billing. The day when one could stand on a corner in the theatrical district and determine what was playing at all of a considerable number of theatres was quite

Glass backgrounds and letters are adaptable to various shaped fronts
(Bergen Theatre, New York City)

far in the future.

Electrically illuminated displays employing cutout letters with exposed lamps were later adopted by the larger theatres which played attractions a week. But their cost, difficulty in handling, and frequent lack of suitable marquee ruled them out for most theatres.

Stage Set for Modern Signs

Thus the stage was set for acceptance of the changeable letter sign. Early versions were crude and sometimes home-made, but nevertheless remarkably effective as against the old billing devices.

Changeable letter display units were developed and their use became universal. Even the smallest theatres soon boasted of this new and effective method of calling attention to their attractions. Therein was the disadvantage, for most marquee billing soon looked alike. To give change of pace to the appearance of this changeable copy, fonts of letters in a variety of sizes were produced and the exhibitor could really go to town in writing the story for his front. Emphasis could be given the important feature, be it title, star, author, producer or director, and still leave room for mention of things or lesser import, or billing of short subjects. Veritable ads could be written to occupy the available space.

In search of still greater effectiveness for this marquee billing, colored lamps were used back of the solid opaque letters and helped in attaining a color or atmospheric mood.

Chicago's White Way

Wagner Develops New Idea

As one of the foremost advocates of doing a real advertising job at the point of sale, Erwin Wagner, head of the Wagner Sign Service, Inc., Chicago, came forward with the next development in marquee billing equipment, a translucent plastic changeable letter.

These new letters, which are now widely adopted by theatres as effective devices for selling a show out front, have many advantages. Though strong and durable, they are lighter than the old style solid metal and wood letters, require less space for storage, and are easier to handle—a point greatly appreciated by anyone who has had the job of lugging the old metal letters up and down stepladders and changing billing when the marquee was encrusted with ice and snow.

Type of display letter, framed in metal

Utilizing the light which shines through them, Wagner letters give forth the colorful brilliance of neon. Available in fonts of assorted colors, red, green, blue, amber and opaque black, from 76 letters up, two sizes have been put on the market, 4 inches and 10 inches.

AIR CONDITIONING

Theatre Air Conditioning

Proper Regulation of Theatre Atmospheres

By NASH WEIL
Vice President, Wil-Kin Theatre Supply, Inc.

A good air conditioning system must perform seven functions. In winter the system must heat, humidify, circulate, filter and ventilate; in summer, it must cool, dehumidify, circulate, filter and ventilate. These functions are not just names—each of them provides definite and necessary results.

Heating and cooling should be under thermostatic control so that occupants enjoy true comfort with no need for continued attention. The desired temperature should also be maintained unformly in all parts of the occupied space. Overcooling in summer is unnecessary to provide comfort, and should be avoided to prevent undue discomfort on entering and leaving.

Eliminating the normal extremely low indoor humidity in winter by controlled humidification aids the membranes of the nose, throat and lungs to function normally and helps guard against respiratory illness. In summer, adequate lowering of humidity indoors is vital to comfort. Cooling without moisture removal produces a clammy atmosphere that brings a greasy perspiration to the skin.

If we could but see it, a rather horrible collection of dust, bacteria, yeasts, spores, and other foreign particles float in unfiltered indoor air. Good filters remove most of these particles and contribute to a more healthful and comfortable atmosphere, besides making it much easier to keep the air conditioned space clean.

Gentle movement of the air indoors helps prevent uneven temperature distribution—chilly at the floor and hot at the ceiling in winter. In summer this air movement helps carry away the heat given off by the body. Compared with still, stagnant air, air that is in motion is invigorating and conducive to greater comfort. Objectionable drafts are quite unnecessary with a properly designed system.

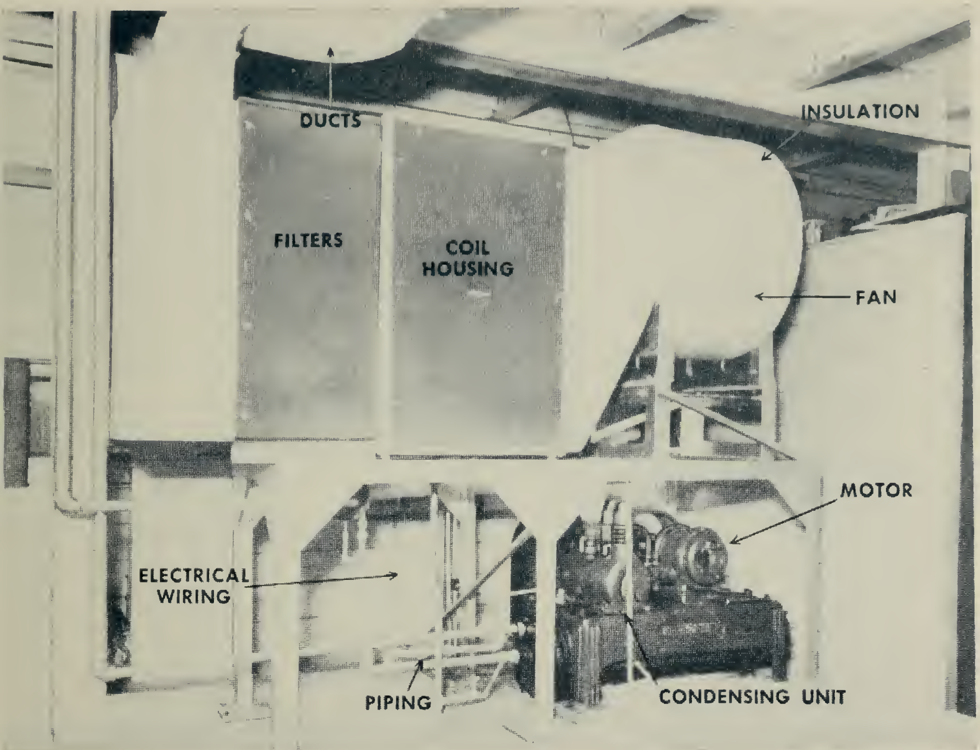
Every air conditioning system should bring in a required amount of outdoor fresh air to keep the building under pressure, to keep the air indoors free from objectionable odors, and to replenish the oxygen supply.

Major Parts of System

The major parts of an air conditioning system are:

(1) The duct system which carries the conditioned air to properly located grilles or registers which diffuse. Ducts also carry recirculated air back to the air conditioner.

(2) An air conditioner consisting of the proper combination of filters, heating coils,



Principal components of an air conditioning system

cooling coils, humidifier, fans and motor.

(3) A condensing unit to send refrigerant to the cooling coils in the air conditioner where the air is cooled and dehumidified. With the heat absorbed in this process, the refrigerant is drawn back to the condensing unit where the heat is extracted.

(4) A heat source, where steam or hot water is supplied to the heating coils in the air conditioner.

(5) Controls for protection against abnormal conditions and for maintaining the desired inside conditions with maximum operating economy.

(6) Piping, wiring, insulation and other items of installation work.

The refrigeration plant of an air conditioning system may consist of several condensing units. By operating only as many as are needed, higher economy, greater flexibility with varying loads, less wear *per machine,* greater reliability, and more completely automatic operation are obtained.

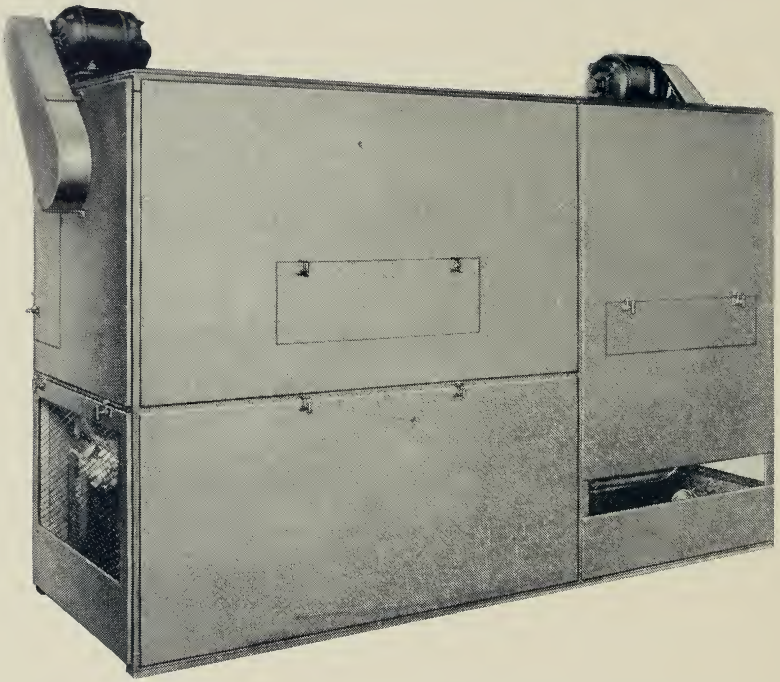
Operation of Air Conditioner

The motor-driven fan draws into the conditioner a mixture of room air and outdoor air from the return and fresh air duct system. Passing through filters which remove 90 to 95 per cent of the dust and dirt, the air next flows over the cooling coils, which are kept cold with refrigerant or chilled water. With coil surface temperatures ranging from 45 to 55 degrees, depending on system design, moisture is also condensed from

the air as it is being cooled.

The cleaned, cooled and dehumidified air is then delivered to the supplv duct system by the fan for circulation to the conditioned space.

The air can also be conditioned in winter by including steam or hot water heating coils and a humidifier in the same air conditioner.



A complete refrigerated air conditioning system engineered into a single unit

The Condensing Unit

The condensing unit is the heart of a summer air conditioning system. In the cooling coils liquid refrigerant is evaporated, absorbing heat from the warm return air passing over the coils. This heat-laden refrigerant vapor is drawn into the motor-driven compressor, pumped up to a high pressure and temperature and forced into the condenser. Here it is condensed back into liquid form by water running through or over the tubes and extracting the heat absorbed in the cooling coils. The pressure of the refrigerant coming from the compressor forces liquid refrigerant to flow from the bottom of the condenser through the liquid line through the expansion valve to the cooling coil.

Thus the heat originally extracted from the air is finally transferred to the condenser cooling water and carried away outside the building.

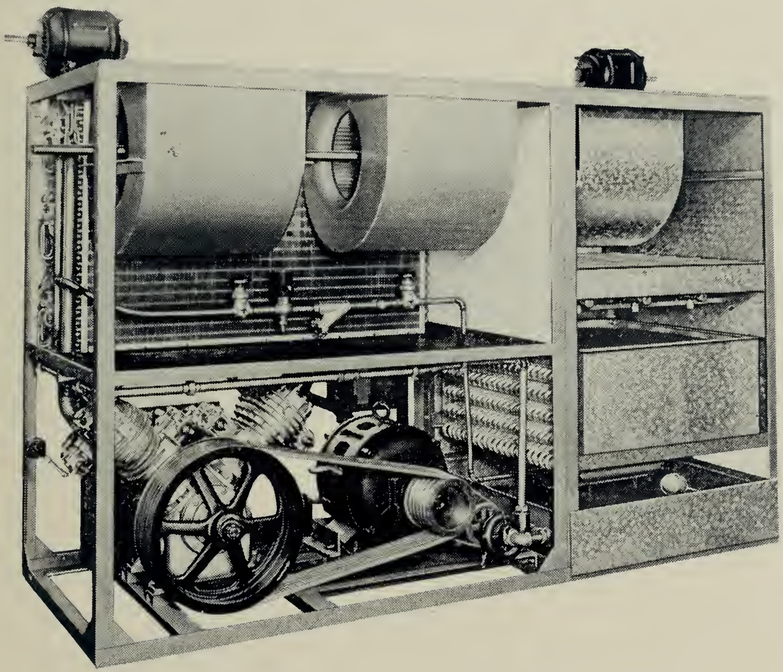
If properly designed, the same air distribution system can be used for both winter and summer air conditioning. Heating coils in the air conditioner are supplied with steam or hot water from a boiler or from the main heating plant of the building. Provision is usually made to temper outdoor air for ventilation either with the main

heating coil or a separate tempering coil. A small amount of hot water is admitted to the humidifier by an automatically controlled valve.

Indirect Systems

It is sometimes necessary or desirable to use refrigerated water in the cooling coils of an air conditioner instead of refrigerant (as in the case of large multiple-zone systems). In such cases the condensing unit is connected to coils in a water cooler to extract heat from water. The cold water is then pumped to the coils in the air conditioner to cool and dehumidify the air, and the water is returned to the cooler to be re-cooled.

If an adequate supply of cold well water is available, it can be pumped through coils in the air conditioner to do part of the job of cooling the air. This water may be used in the condenser of a condensing unit connected to refrigerant coils which complete the cooling and dehumidifying of the air. Only occasionally are conditions such that no refrigeration is necessary to produce proper humidity reduction.



Air conditioning system with outer casing removed

Where city water is expensive or well water not economically available, a cooling tower and pump may be piped to the condenser of the condensing unit, and the piping, condenser and cooling tower pan filled with water. Controls are arranged so that whenever the condensing unit runs, the pump starts and forces water through the condenser to the sprays in the cooling tower. Natural movement of wind through the sprays cools the water by evaporating a small amount which is compensated for by supplying make-up water through a float valve.

The cooled water collects in the tower pan and drains down to the pump inlet.

Forced draft towers with fans to blow air through the sprays are also used when the cooling tower cannot be exposed to natural outdoor air movement.

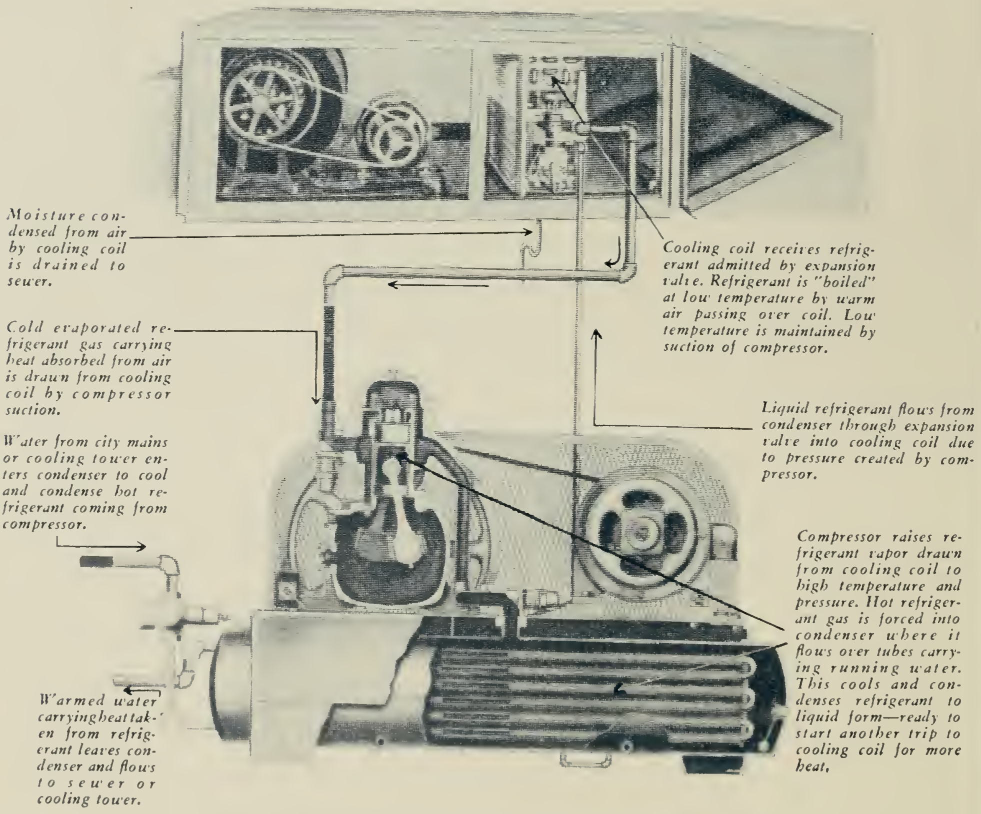
Another method of conserving water is to use an evaporative condenser instead of the regular water-cooled condenser. In this case the hot refrigerant gas from the compressor is piped directly to a coil in the evaporative condenser. A small pump sprays water on the coil, and a fan blows over it to condense the refrigerant to a liquid. Some of the water is evaporated, and make-up water is supplied through a float valve. The condensed liquid refrigerant is then forced to the expansion valve or the aii conditioner by the compressor pressure.

Points in Buying

In buying an air conditioning system, the following points should be considered:

1. *Buy equipment with low electrical consumption.* Condensing units must have highest refrigerating output per kilowatt of electric power consumed; fans must use minimum power for required air flows and pressures; efficient motors must be used.

2. *Buy equipment with low water consumption.* This means condensing units which inherently use less water per unit of

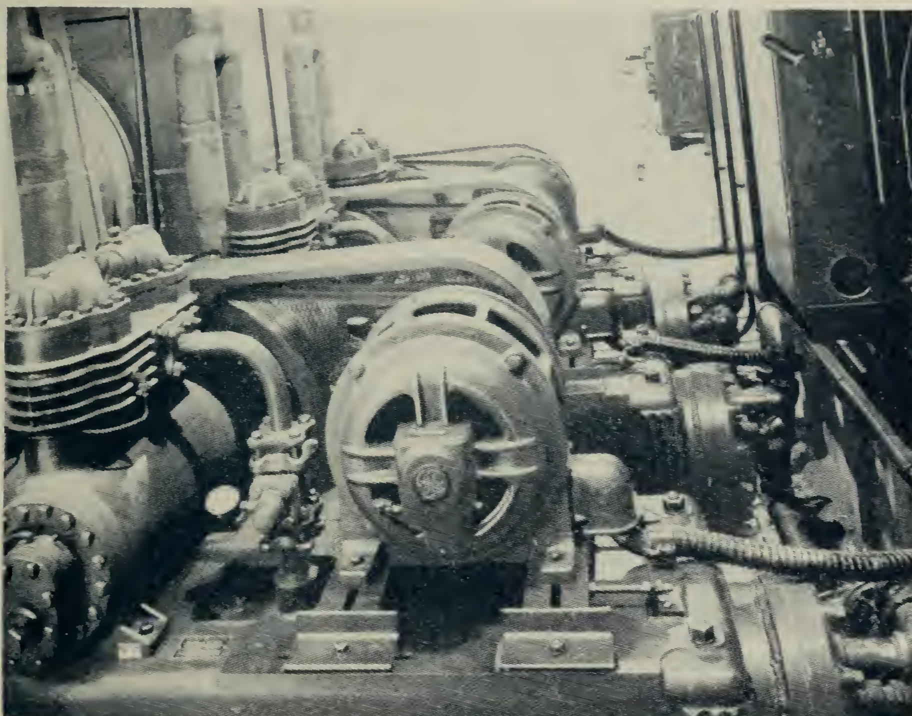


How the condensing unit functions

refrigerating output; it may mean using a cooling tower or evaporative condenser to conserve water; and it means using condensers which can easily be kept clean to maintain power and water consumption at a minimum.

to keep fan power requirements to a minimum.

5. *Consider the cooling load.* Make sure that the system you buy is designed to produce the proper relation between temperature reduction and moisture removal. Too



Condensing units employed in a theatre air conditioning system

3. *Buy a properly controlled system.* Automatic ventilation control, control through the use of multiple condensing units, automatic regulation of indoor temperature in relation to outdoor temperature to prevent over-cooling, zone controls and others can reflect substantial operating cost savings and more than pay for themselves.

4. *Buy a well-designed air distribution system.* Ducts should be of ample size, with avoidance of unnecessarily long runs, and should be properly designed mechanically,

much capacity for one or the other is uneconomical. Check the possible use of awnings, venetian blinds, insulation, attic ventilation, and any other expedients which may reduce the cooling load and save on first and operating cost.

6. *Buy high quality equipment for long life and low maintenance cost.* The longer the life of the equipment, the lower its ultimate cost. Only high quality products will give lasting service with fewer repairs, fewer interruptions of service, and contin-

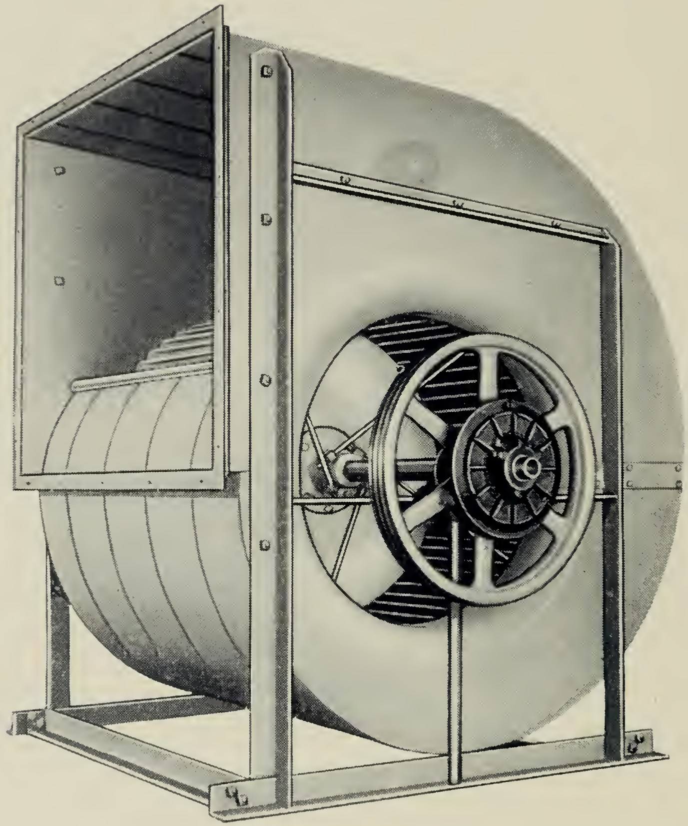
ued efficient operation.

How to Buy Equipment

One cannot buy needed air conditioning equipment as one might select some simple product. It is necessary that a system be tailored to fit the particular needs of the building it is to air condition.

Your dealer will most likely spend many hours studying your premises to discover how to secure harmonious appearance, how to reduce capacity requirements for lower first and operating costs, and how to obtain quiet operation and freedom from drafts.

He will tell you that it is important to avoid selection of equipment that is too small because measures taken to increase the capacity of an under-sized installation seldom result in first-class performance.



Double intake blower of air conditioning system

He will analyze the following five sources of heat and moisture which constitute the cooling load:

Heat leakage through walls and windows.

Heat from the sun.

Heat and moisture from occupants.

Heat and moisture from ventilation air.

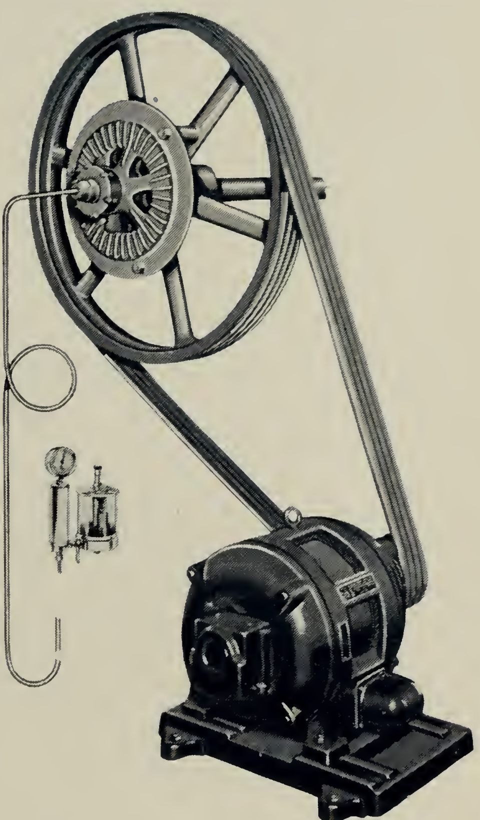
Heat from lights, appliances steam pipes, etc.

As several of these vary with time of day, all of them will be studied for possible expedients to reduce their magnitude and hence the cost of the installation.

Reduction of indoor humidity through adequate moisture removal is the most important function of summer air conditioning. The proportion of moisture load in relation to the total cooling load is different for each installation and depends upon coil surface temperature, air velocities and coil design. Your dealer will therefore precisely determine the proper relations of all of these factors for your particular application so that your air conditioning system will prevent that sticky humidification.

Your dealer will tell you that the circulation of a small amount of air may save something in fan and duct costs, but inadequate air movement in occupied spaces is almost certain to result. Small air flow also requires excessive temperature reduction of the air in the conditioner to handle the cooling load, with resulting danger of drafts and inefficient operation. From eight to ten "changes" per hour represents good practice, though considerable variation from this range may be permitted in specific cases. Sufficient outlets should be provided to prevent concentrated air movement. Ventilation air from outdoors must be provided mainly for odor and oxygen control. In theatres with heavy occupancy, the ventilation air should range from 10 to 30 c.f.m. per occupant, depending on the probable amount of smoking and other odor sources. Skimping on ventilation air may cheapen the installation, but only with proper ventilation can a pleasant and inviting atmosphere be obtained.

He will also state that safety and limit controls are, of course, necessary for protection against external abnormal conditions such as power or water failure. Every good air conditioning system should also have complete automatic control to provide greatest operating economy and best maintenance of air conditions. Automatic control of ventilation air and automatic regulation of indoor temperature according



Hydraulic variable speed control for blowers

to outdoor conditions helps to minimize operating time and hence saves money. An adequate amount of automatic control equipment usually pays for itself and saves money besides. Careful tailoring of the system to the required loads, adequate but not excessive air flow, expedients to reduce cooling loads, selection of water conserving equipment when justified, proper design of control system, arrangement of system to

keep duct and pipe runs as short as possible, all result from competent application engineering and keep operating costs at a minimum.

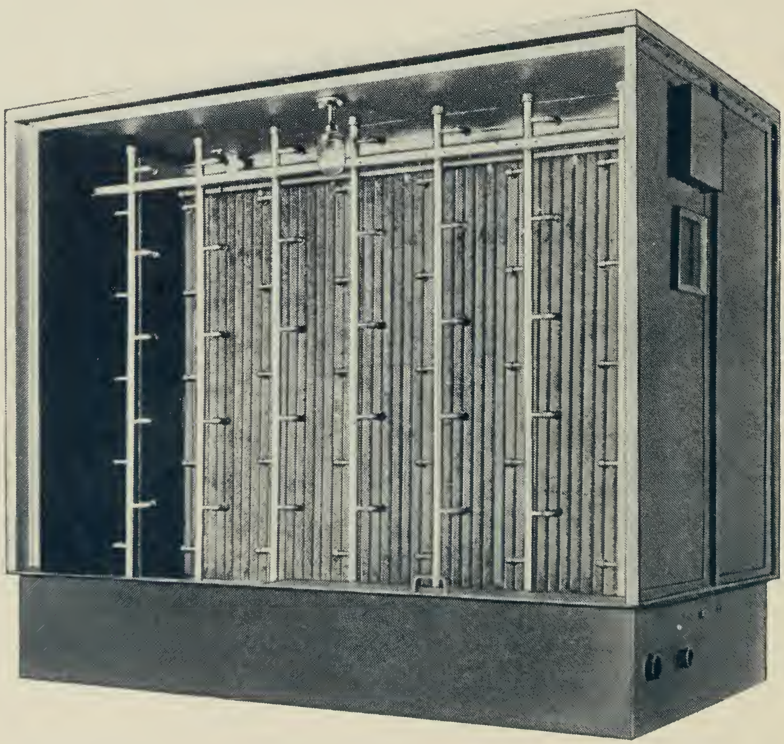
Within the limitations of good accessibility, the careful dealer endeavors to make use of waste space for equipment locations. Where such space is not available, air conditioners may be suspended at the ceiling above head level or mounted on a stand above the condensing unit. For large installations it is highly preferable to locate the compressor equipment in the basement, but other equipment may be located in a penthouse on the roof to avoid use of space in the building.

Installation of Equipment

To insure long life and perfect functioning of your air conditioning system, your dealer will give you good sheet metal, electrical wiring, insulation, piping and building construction work.

Proper sizing and design of ducts, isolation of mechanical sound and vibration by use of flexible connections and suitable foundations, careful selection of fan sizes and speeds, and application of soundproofing material at critical points should all be considered in the design of air conditioning systems to give quiet operation without appreciable extra cost.

A high quality duct system is essential to good air conditioning, and it is false economy to accept inferior ductwork to gain lower first cost. Good sheet metal does not sag or distort; there are no air leaks to increase operating cost; seams, turns and



Air washer of the standard nozzle type

fittings are made to promote smooth air flow and guard against noise and excessive fan power consumption.

High quality ducts are erected in accordance with the recommendations of the American Society of Heating and Ventilating Engineers and will save money in operating cost, present good appearance, contribute to safety of operation, and give lasting, reliable service.

The electrical currents pulsing through the power and control wiring give life to the air conditioning system. It is vital that the electrical work meet the highest standards of quality to insure reliable operation, and give absolute safety throughout the life of the system.

Insulation of roofs, ducts and pipes for economy of operation and to prevent "sweating" of cold surfaces must be thoroughly and carefully done. Insulation must not be omitted just to save in first cost.

High quality piping contributes to lower ultimate cost and guards against refrigerant leakage and damage to the building. Skilled workmanship and good materials are insurance against leaks and will save money in operating and maintenance costs. Good appearance is also characteristic of good piping.

Openings cut in walls and floors for the passage of ducts and pipes, furring of ducts, foundations, machinery room construction, reinforcing and other construction work must be done by competent workmen in keeping with the original structure of the building.

A competent dealer makes a thorough study of the building structure and the appearance of occupied spaces so that he may arrange the ducts that can't be concealed and distribution outlets to harmonize with the interior. Whenever possible, he attempts to achieve symmetry through balance design and regularly spaced grille locations. Generally any air conditioning system can be installed so that it will not detract from the attractiveness of an interior if concealed or furred ducts are used.

Reasons for Air Conditioning

An air conditioning system is not an accessory or an appendage to the premises. A properly installed system becomes a permanent part of the building, designed to last for many years, and should be installed with the same care and thoroughness with which the building itself was constructed.

THEATRE MAINTENANCE

Building Maintenance

Theatre Neglect Means Costly Repairs

By JAMES T. REDD

The proper maintenance of buildings is of extreme importance, because they represent a large capital investment and protect all the interior equipment. Proper care of buildings requires preventive maintenance. The three primary principles of good building maintenance are: (1) anticipation of trouble, (2) inspection for damage, (3) immediate repair of damage. Remember that with buildings, a "stitch in time saves nearer 90 than 9." A neglected five-dollar-repair may easily mean a several-hundred-dollar-expenditure a few months later.

Copings

Coping provides a finishing cap for the top surface of the parapet wall and serves two purposes:

1. Protection of the wall structure against moisture absorption from rain or melting snow. Absorbed moisture under various temperature changes will cause damaging expansion and contraction and will dissolve the soluble compounds in the mortar and brick. Both actions greatly accelerate the disintegration of the wall structure.

2. Decorative trim.

Coping that is not water-tight does not properly protect the wall structure. Mortar joints of tile, stone and terra cotta copings and soldered joints or metal coping must be checked every six months and kept in a water-tight condition. Defective concrete coping should be repaired immediately. If it is found to be loose or cracked, or if the joints are not properly sealed, immediate repairs will prevent wall structure deterioration which progresses very rapidly once it starts.

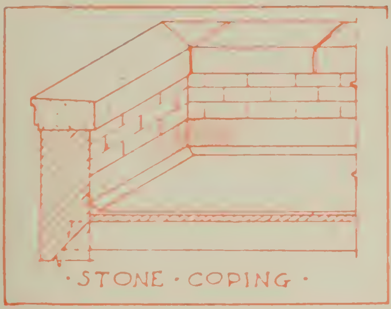
Parapet Walls

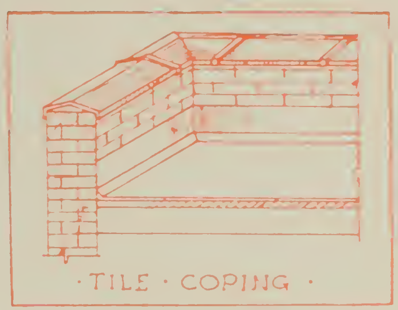
A parapet wall is that part of the wall structure which extends above the roof surface.

When inspecting parapet walls, look for cracks, loose mortar and disintegrated building material. Most troubles in parapet walls come from defective copings, but the walls may become damaged by extreme temperature conditions because they have no protection from the weather on either side.

Parapet walls should be structurally sound, as weak ones present a definite hazard of life and property below because they may fall under heavy load conditions from wind, snow, and sleet. Inspect thoroughly and replace bad sections if it is apparent that structural weaknesses have developed. Small cracks and open mortar joints may be satisfactorily sealed with cement, mortar, or a sealing compound.

Much water damage to the interior of theatres is caused by defective copings and





parapet walls. Water will seep into the wall above the flashing, flow around the edge of the roof and into the interior of the building. Leaks generally show up as wet spots on the side walls and ceilings, and can result in expensive plaster damage and rotting of decking and trusses.

Flashing and Counter Flashing

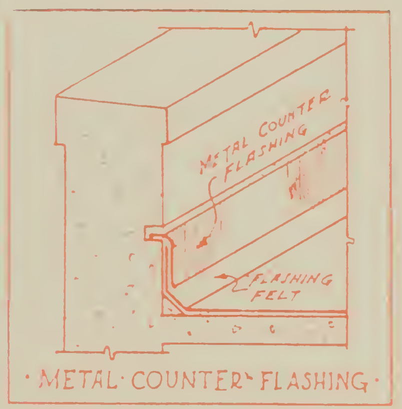
The flashing and counter flashing provide a water-tight seal between the roof covering and the parapet wall. The flashing is formed by extending each layer of the roof felt up along the parapet wall. The first layer is border to the wall and succeeding layers are cemented together with tar or asphalt.

A metal strip called the "Counter flashing" is embedded in the wall above the top of flashing and bent down over it to prevent water from seeping between the flashing and the wall. The metal counter flashing also protects the felt flashing against accidental damage from shoes or tools.

Many roof leaks result from poor or damaged flashing and counter flashing. Therefore, these parts of the roof should receive the most critical inspection. Check flashing for breaks in the felt, ripped seams, pocket formation and loose bond between felt and wall. Check counter flashing for rusting, broken seams, holes and loose connection to wall.

Care of Flashing and Counter Flashing

1. Keep roof clean to prevent damage in flashing.
2. Repair immediately all loose, broken or rusted counter flashing.
3. Keep felts of flashing well cemented together and to wall.
4. Keep the flashing felt covered at all times with asphalt or tar.
5. Keep metal counter-flashing well painted and sealed.



Types of Roofs

1. Built-up asphalt.
2. Tar and gravel.
3. Locked-seam soldered tin.
4. Standing-seam tin.
5. Tile.

Built-Up Asphalt Roofs

The specifications for roofs of this type generally provide for a certain number of

layers of felt of a given quality and having a definite weight per 100 square feet, commonly called a "square." The method of applying the first layer will depend upon the deck structure, it being nailed to wood decking and cemented to concrete with hot asphalt. The succeeding layers are cemented together with hot asphalt and the top layer is treated with a heavier coating of asphalt, called the "flood coat."

The first sign of failure will be the disappearance of the flood coat of asphalt on top of the felt. If the asphalt is applied too heavily, it tends to crack, exposing the felt. When this happens, apply a new coat of hot asphalt to cover cracked areas. If the flood coat has not cracked, then look for areas where it has worn off. Recoat any unprotected spots.

Buckles and blisters often occur in this type of roof due to the faulty laying of the felt. They are caused by the separation of the felt layers which is usually caused by the failure of the bonding asphalt. The felt forming these blisters will quickly deteriorate and open up. The resulting pockets then gather dirt and water which will deteriorate the under layers. If buckles and blisters are not too numerous they should be slit open and cleaned out. The felt should then be tacked together, a new piece of felt imbedded and a coating of hot asphalt mopped over the repaired area. Be sure to coat the entire patch. If the buckles and blisters are very numerous, consult a competent roofing contractor.

Built-up asphalt roofs should have a new top coating of asphalt when large areas of the roof show signs of wear. In the meantime, it should be carefully inspected twice a year for the defects discussed above.

Tar and Gravel Roofs

For this type of roof the felt is saturated with tar when manufactured and is applied in the same manner as built-up asphalt roofs except that the bonding, cement and flood coats are tar products instead of asphalt. After the flood coat has been applied the roof is covered evenly with a specified amount of gravel or crushed stone. The flashings are not treated with gravel.

Tar has a lower melting point than asphalt and will tend to run more easily. This effect is slowed down by the presence of the gravel. If the tar does run excessively and the flood coat disappears, the felt will quickly dry out and deteriorate. The best way to inspect this type of roof is to sweep away the loose gravel from several areas and examine the condition of the flood coat. If the flood coat has dried out or cracked apply a new flood coat and redistribute the gravel. Do not wait until the felt has deteriorated to recoat it. The gravel or stone protects the felt against wear and reduces roof temperature by reflecting part of the sunlight.

Buckles and blisters occur in this type of roof for the same reasons they do in a built-up asphalt roof. They are detected when walking over the roof. Follow the same procedure for repairing them as outlined for built-up asphalt roofs, but use tar instead of asphalt.

If you decide to apply a new covering over an old tar and gravel roof, be sure to investigate the combined weight and see that it falls within the safe load limit of the roof structure.

Locked-Seam Soldered Tin Roofs

Tin roofs are seldom used on theatres because the noise produced by rain and hail interferes with the sound system. Most marquees, however, have this type of roof. Rust is the greatest hazard of tin roofs. The roof should be properly protected against this hazard by the application of paint. The important thing to remember is that rusting should not be allowed to occur. It is much cheaper to prevent corrosion than to treat it. If in the event rusting does occur, be doubly sure that all affected areas are thoroughly cleaned before applying the protective paint. If the roof

temperatures below a tin roof are exceptionally high during the summer months, they may be reduced by using aluminum paint for the finishing coat.

Standing-Seam Tin Roofs

This type of roof may be identified by the standing or upright seams of about one inch height which run parallel to the direction of water flow. Extreme care must be taken to prevent damage to these seams by stepping or permitting things to fall on them. Maintenance of this type of roof is the same as for locked-seam soldered tin roofs.

Tile Roofs

Tile roofs may be of the flat type, formed by laying tile blocks on concrete or wood decking which has been flooded with hot asphalt. The joints between the tiles are also sealed with hot asphalt or other sealing compounds.

Spanish type tile roofs are built up of overlapping half-oval tiles which are supported in the center by wood strips.

Tiles are loosened by expansion and contraction during temperature changes. They become cracked by the freezing of absorbed water. Both conditions permit leakage resulting in rotting of supporting structure and looseness permits falling of tiles which can cause personal injury and property damage. Inspections should be frequent and repairs made as soon as needed.

Guaranteed, Bonded, Leased Roofs

Guaranteed roofs are those which are guaranteed for a specified length of time by the installing contractor, who is obligated to repair all leaks that occur during that period. Managers are responsible for reporting leaks to the contractor before damage to the building interior, for which the contractor is *not* responsible, has occurred. If leakage occurs, and the contractor is unwilling to live up to his guarantee, it would be unwise and costly to permit it to continue until interior damage has increased, so repairs should be made immediately at theatre expense, with later effort being made to collect their cost from the contractor.

Bonded roofs are those that are actually bonded against failure by some casualty company for a definite period. The manufacturer is responsible for the quality of the roofing and the contractor for its proper installation. If a bonded roof fails, recourse can be made to the contractor, manufacturer and bonding company. Another advantage of having roofs bonded is that more care is taken by the contractor in installation. When repairs are needed, the bond should be referred to and its instructions carefully followed.

If the theatre is leased and the upkeep of the roof is the responsibility of the owner, he should be required to make repairs immediately after leakage is discovered. It would be poor business, however, to allow poor roof conditions to remain, as the resulting damage to the interior is the responsibility of the lessee. Instead of engaging in long discussions or controversies with the lessor, the theatre should have repairs made if the lessor won't do so promptly. Later efforts to settle with the lessor can be made.

Roof Inspection and Maintenance

All roofs should be inspected in early spring and late fall for defects, and inspected monthly for cleanliness. Keep all roofs clean to prevent gutter stoppage and consequent roof flooding. Never erect any temporary structure on a roof. When bad roof conditions are located they should be repaired immediately. Extensive snow accumulations should be immediately removed to prevent overloading and flashing leaks.

Downspouts and Gutters

Downspouts and gutters are used to carry off water that collects on the roof. In providing for its quick removal, they prevent it from flowing over the flashing and from standing on the roof.

If downspouts are made of galvanized

iron they must be checked for corrosion and loose joints. If they are of copper, the soldered joints must be checked. Wire screens must be set over downspout openings and screens and boses kept clean and free from leaves, dirt and other refuse. During winter months, any ice formation over these openings should be removed immediately.

When inspecting gutters, be sure to check the inside surfaces, as they are the most important, since they handle the dirt, gravel and rain. The interior surfaces should be thoroughly cleaned every six months and repainted when needed. The exterior surfaces should be inspected for scaling paint and corrosion.

Skylights and Penthouses

There are many designs of skylights and penthouses. Quite a few of the sheet metal construction, particularly, are made in such a way as to render the replacement of almost any part or section, which might through corrosion become defective, a rather expensive undertaking. This fact only serves to further emphasize the importance and necessity for making a very careful checkup as to the condition and then carefully maintaining the efficiency of the protective coating, particularly at all joints or intersections. All condensation drains should be checked and kept open. Inspect thoroughly the flashing and counter-flashing around the edges of the skylights and penthouses, and keep it in good repair. Serious roof leaks often occur here. Inspect carefully the glazing on skylights and keep it watertight. Replace when putty becomes cracked and loose. Keep all metal surfaces well painted.

Steel-Stacks

Guywires, foundations and fittings, as well as the stack itself, should be carefully checked and, if needed, promptly repaired to insure general safety. Check the flashing and keep all parts of the stack and fittings well painted to prevent rusting.

Brick Chimneys

Improperly maintained chimneys present a hazard to the roof and those occupying the space below. Carefully check the mortar joints, coping and brickwork for cracking. Do not allow bad conditions to remain. It is much cheaper to repair a chimney than to replace it and repair the roof after it falls. Sealing of seams at proper intervals will prevent development of cracks and general failure.

Ventilators

The main problem is that of prevention of corrosion. Often it is possible to paint the inside as well as the outside surface of the ventilator, which is seldom, if ever, done. Where it is possible it should be done. The flashing around the ventilators should be carefully checked and kept in a water-tight condition. All surfaces should be kept well painted.

Deck Structures

The roof structure is an excellent place to check for roof and flashing leaks. Where the type of construction allows you to visibly inspect this part of the buildings from the attic it should be done every six months. The deck supports the roofing and generally represents a rather large investment. If you can locate leaks from inspection you can prevent damage to the interior. If the deck is of wood construction, it will usually absorb large quantities of water before leaks become visible from below. When this happens, the structure will rot and dangerously weaken the roof. Examine this part of the building at least every six months.

Make regular inspections for evidences of leaks. Locate and repair any that are found. It is not necessary to replace deck structure solely because it has become wet, but when rotted areas are found, be sure to have them inspected by an experienced building contractor.

Some large electrical fixtures are so located that they cannot be relamped or

cleaned without lowering them to the floor. This operation may be done by rope or by the use of winch. In either case, carefully inspect every piece of equipment used and keep it in a safe, working condition. When the fixture is in place carefully check the position of the holding equipment, and be sure that it cannot possibly allow the fixture to fall. If a winch is used, be sure that it operates properly and is well secured before attempting to lower the fixture, and that its safety catch is securely locked after the fixture has been raised into position. Inspect all stationary light fixtures regularly to be sure that they are properly secured.

Trusses and Beams

If the trusses and beams are of steel, check for rusting, sweating, loose connections, failure at bearing points and sagging.

If the beams and trusses are of wood construction, look for rot, loose connections, loose joints, loose splices, cracking, warping, failure at bearing points, sagging and insect infestation.

Make necessary repairs immediately after bad conditions are found and verified by a competent, licensed engineer, or architect, who should be employed to recommend the method of safely repairing damage.

Strategic Points for Deterioration

The figure shows the location of those parts of a building which are most likely to deteriorate. Each point of failure is numbered on the figure, and the cause of failure is explained. A careful study of this figure should be helpful in making a thorough building inspection.

1. Defective Mortar Joints in Coping Materials or Defective metal.

2. Cracked, broken, loose or missing coping units.

3. Defective flashing and counter-flashing at parapet walls.

4. Defective mortar joints in parapet walls.

5. Poor grade of mortar and poorly constructed mortar joints on exterior surfaces.

6. At all jointing of cornices, sills, trim and projecting courses of brick where comparatively flat surfaces are in evidence, and also vertical mortar joints.

7. Weather-exposed surfaces of brick units.

8. Acid attack due to sulphur dioxide during rain, snow or damp weather. (Not Shown.)

9. Absorption of earth moisture at ground level.

10. Exposure to wet or damp inside conditions.

11. Defective or under-sized conductor heads, gutters and downspouts permitting increase in volume of flow of water over the wall surfaces.

12. Increase in flow of water over all wall surfaces in the absence of projecting trim and sills.

Fire Escapes

Importance of safe fire escapes need not be emphasized. Everyone is aware of their purpose and those responsible should see that they are properly maintained. The adjustment of counter-balance weights is quite important. Check this section of the escape regularly during periods of snow and sleet to be sure that it has not lowered to the point where it presents a hazard to those passing below. All fire escapes should be kept free from snow and ice accumulations. All structural supports and wall fasteners should be carefully checked for corrosion and loose joints. Keep the escape well painted and all connections tight. Do not permit bent or loose handrails or bent steps.

Vertical Sign and Marquee Maintenance

Vertical signs and marquees are quite expensive, and too often costly repairs can be traced to poor maintenance. Be sure that all struts, hanger rods, turnbuckles and holding bolts are safe and free from rust. Check turnbuckles with a wrench to be sure that all hanger rods are under tension and are carrying their proper part of the load.

A marquee roof should be checked as outlined under "Building Roofs," paying special attention to the condition of the flashing. *Keep the roof clean and all drains open.* Carefully remove snow accumulation so that the marquee will not be overloaded. Do not use a marquee roof as a storage space and never install heavy displays there. Don't puncture the marquee roof. Keep the interior and exterior of the marquee sign boxes as clean as possible. A clean interior is less liable to be seriously damaged when a leak develops. Have all marquee leaks fixed immediately—do not wait until the sign is seriously damaged. Paint as often as necessary.

Door Maintenance

The key to good door maintenance is the proper care of the door edges. Keep all edges well painted and use a small mirror to check the bottom edges. The swelling of wooden doors is caused entirely by the absorption of moisture. Keep all wood surfaces well protected against moisture absorption by the use of the proper paints. When inspecting doors, be sure to check the tightness of hinge connections both on the doors and on the frames. Poorly maintained door closers have ruined as many doors as any other one thing—keep them tight. If the doors become loose at the glued joints, do not use metal straps, but insert wood dowels and re-glue.

Windows

Inspect wood frames and sash for surface failure which will allow absorption of moisture. Look for loose putty around window panes. Repaint defective surfaces and replace loose putty. Inspect steel frames and sash for rust and be sure to have it properly cleaned before painting. Check both types of frames and sash for looseness. Weatherstrip and caulk them if

they can materially affect the heating or cooling load.

Inspection of Plastered Walls

When inspecting plastered walls and ceilings, look for the following defects:

1. Cracks.
2. Loose plaster and plaster ornament.
3. Moist areas.
4. Blistering and peeling of paint.
5. Efflorescence.

When bad conditions are found, try to locate the cause before making repairs. Roof leaks, wall seepage, broken laths, sagging beams and other factors may affect interior plaster.

Efflorescence may appear on plaster as a salty deposit and in severe cases the plaster may be reduced to a soft powder. It is usually caused by the presence of moisture and soluble salts in the structural backing. Wood or metal lathing usually prevents efflorescence. Efflorescent defects first appear in small discolored spots, followed by white crystal formations which finally break through the paint leaving exposed crumbling surfaces. Remove such areas, waterproof the supporting structure, and replaster.

Accepted Practices for Painting Plaster

1. Before applying paint, examine the surface carefully and be sure the plaster is tight.
2. Whenever plaster has been applied directly on tile, brick or cement, examine the surfaces carefully for any signs of efflorescence. Remove such areas, waterproof the structural wall or replace the lathing before replastering.
3. Do not use zinc sulphate solution on plaster.
4. Do not use glue or varnish size.
5. Use oil base rather than varnish base paints to assure against blistering and peeling troubles.
6. Have the surfaces clean before applying paint.
7. Be sure the plaster is dry and well cured if new.

Stairways

Stairways are a source of danger even under the best conditions. For that reason the problems of keeping treads clean and free of oily or other slippery substances and of keeping stairs and railings in a structurally sound condition are important. Cracked, chipped, splintered, or broken step nosing is one of the most prevalent hazards caused by defective structure and should be constantly sought out and repaired. Keep all hand-railings securely fastened and the area in contact with the hand smooth. Torn carpet on stairway treads should be immediately repaired. Loose carpet is a common hazard and should not be allowed to remain in that condition.

Fixed Ladders

Ladders are dangerous even under the most favorable conditions. To prevent serious accidents be sure that all ladders are structurally sound and well secured at both ends. Special attention should be paid to the condition of rungs. Replace immediately all defective rungs and acquire the habit of inspecting ladders when they are being used.

Stage Rigging, Lofts, Fly Galleries and Pin Rails and Counterweights

Stage rigging lofts and fly galleries are subject to the same structural defects that occur in floors, trusses and beams, but by the nature of their use they are more likely to be loaded beyond their designed capacity. Overloading must be avoided and the structural members, sheaves, rope and cable must be kept in a high state of repair. When checking these points of the theatre, look for structural defects in supporting members, loose, or defective sheaves and sheave fastenings, rotten or frayed rope, rusty or frayed cable, loose or slipping cable clamps. Look for cracked or loosely threaded battens from which

the stage scenery is hung. Poorly secured or structurally weak pin rails present another hazard. Be extremely careful in the handling of counterweights. Keep all lines, cables, sheaves and arbors in excellent condition. Be sure to use correct size sheaves.

When checking concrete floors, look for cracking, chipping, dusting and surface moisture.

Ceramic tile floors should be checked for loose and broken tile and slippery surfaces. Any loose tile should be immediately re-set and any broken tile immediately replaced to prevent progressive damage to the floor.

Terrazzo floors should be checked for bad cracks, loose sections and slippery surfaces.

Paint will not bind to oily, greasy or damp surfaces, so before painting wood or concrete floors, be sure that they are clean and dry. If wood and concrete floors are badly deteriorated, have them inspected by a competent building engineer for repairing.

Foundation Walls

Inspect foundation walls and footings, if accessible, for water seepage through walls and underfootings.

Fire Extinguishers in the Theatre

A theatre well supplied with fire extinguishing equipment is not necessarily well protected against fire of internal origin. There is a right way and wrong way to do everything.

Though much has been written about how to choose the correct fire extinguisher and how to keep it in fire fighting shape, very little information has been given about where extinguishers should be placed with relation to fire hazard and occupancy. Many fatal and costly fires can be prevented if dealt with in their incipiency. But — in order to win the battle with fire—the extinguisher must not only be the correct type for the hazard it guards, but it also must be properly placed.

Here are six good rules to follow in the placement of extinguishers:

1. Locate close to likely fire hazards.

2. Place the extinguishers so that fire will not block access to them.

3. Locate enough units to deal with any blaze that might be expected.

4. Locate the extinguishers conspicuously, so that everyone will be familiar with the locations.

5. Identify each unit for the type of fire it is designed to combat.

6. Protect the extinguishers from the traffic of passersby.

An extinguisher may be useless if located where precious seconds are lost in getting to it and back to the fire. Employes should have ready access to extinguishers for immediate use following the discovery of a blaze.

Don't always place extinguishers at the end of aisles, and don't locate them in stairwells. Flue action fans fires, preventing access to equipment.

The units in theatres should be so located that a person will not have to travel more than one hundred feet from any point to reach the nearest unit, and at least one unit should be supplied for each 2,500 square feet of floor space.

Most extinguishers should be placed so

that their tops are not more than 5 feet above the floor. These include carbon dioxide units with capacities of 10 pounds or less; water under 5 gallons; foam vaporizing liquid under 2 gallons; loaded steam, soda acid, dry compound and water and sand pails. Pails, however, should not have their rims less than 2 feet above the floor. The 15 and 20-pound carbon dioxide, 5-gallon water, 5-gallon foam and 2 and 3-gallon vaporizing liquid types should have their tops not more than 3½ feet above the floor.

Carbon dioxide and vaporizing liquid types should be hung on hangers supplied by the manufacturer, while the others may be hung on hangers or set on brackets or shelves. Wheeled extinguishers, added where extra hazards require, should be accessible, and adjacent doorways and alleys must be kept clear to afford ready passage.

There are several ways to make the locations of extinguishers conspicuous, well-known and readily seen despite excitement which normally attends the outbreak of fire. A large red spot painted on the floor or aisles under the location of an extinguisher or a vertical red band with yellow borders down a side wall or column where equipment is located act as constant reminders. Lights of distinctive color or signs "For Fire" with arrows pointing to extinguishers are other useful devices.

Good housekeeping is important; in addition to protecting extinguishers from traffic, keep boxes, cartons or other materials far enough away to allow ready access to all units. Also, see that the extinguishers are not used for hat and coat racks and similar purposes.

And last but not least, instruct the fire brigade on the location of all units and acquaint them with the operation of each type of extinguisher. But don't rely wholly on first aid equipment. Have direct fire station pull boxes in the theatre. Attack the fire as quickly as possible and always summon the fire department.

FALL HINTS FOR THE EXHIBITOR

At this time of year, every exhibitor is giving consideration to the months to come and the temperature change which is bound to result in territories other than semi-tropic.

—He will check his furnace and see that there are no leaks in his boiler; he will see that flues are properly cleaned and that there are no warped or burned out grates in the fire box. He will check his radiators and see that all connections are tight, and that the steam valves are functioning properly.

—He will check his downspouts and roof gutters, and see that all dead leaves, gravel, etc., have been removed, so that when ice cakes it will not break his downspouts.

—He will check his marquee, see that the drains are working properly, see that all flasher boxes are tight and that contact fingers are making perfect contact.

—He will check his supports for the marquee letters as well as his letters, and see that all rust is removed and same are painted.

—He will check his fire escapes, remove the rust with a wire brush, and then paint for the winter. Snow covers fire escapes for many months during the winter, and if rust is not removed now it is very likely to eat through the metal.

—He will see that all excess fans used in the summertime are properly cleaned, oiled and covered up during the winter months.

—He will change his house lighting back to warmer colors, and discon-

tinue the use of blues and greens.

—He will check his storm doors and see that all door checks have been properly adjusted and those that need new packing have been given attention.

—He will check all windows, see that they are properly puttied and are tight.

—If the exhibitor has his own billboards, he will see that they are properly anchored, in good repair and painted for the winter.

—This is a good time of the year to check your seats, patch those with some rips or tears, recover those that so require.

—Drapes and curtains should be cleaned in the early fall because summer dust and dirt has collected.

—It is also a good time to put in that new screen.

—See that weather-stripping is in proper condition around the stage entrances and exits.

—Make sure your fire equipment is in proper working order, that recharges have been put in your fire extinguishers and that no loose wiring is left from summer exploitation.

THEATRE NOTES . . .

When moving a rubber mat, never grasp it by the nosing. Always roll up the mat before moving.

• • •

Once a week clean out the fluff from the interior of your ticket machine. Allowed to stay, fluff will get into the working parts of the machine and prevent its perfect operation.

• • •

Check your seats carefully for snags that will ruin stockings. A run in a pair of Nylons may cost you a patron for life.

Imitation leather may best be cleaned with water and a mild soap. After a soap cleansing, wipe off the soap with clear water and dry with a clean cloth.

• • •

If you do not have matinees in summer, keep your house closed and dark during the day. It will help to keep in the cool air for night performances.

• • •

A summer hint—crash runners for carpets give a cooling effect.

• • •

THE FACE ON THE COVER

I would like to subscribe to THE SOUND TRACK.

I was cleaning out the booth one day and saw a book. As soon as I saw the cover I knew it was a good book. The date on the book is April, 1944.

D. B.

PART THREE

RECENT THEATRE DEVELOPMENTS

Drive-In Theatres

Some Guiding Rules for Building and Equipment

By FRED C. MATTHEWS
Vice President, Motiograph, Inc.

There has been a tremendous increase in the popularity of the Drive-In theatre since the close of the last war. This marked success has convinced a great many in the motion picture industry that Drive-In theatres are not only a permanent part of motion picture exhibition, but an increasingly important and lucrative one as well. It is the intention of this article to discuss primarily the construction and equipment of these outdoor auditoriums, but it would not be amiss to devote a few paragraphs to the reasons for their popularity.

The potential field of patrons for a Drive-In theatre includes all car owners within reasonable driving distance. More specifically, it appeals to those who do not wish to dress up, to those who cannot obtain "sitters" for small children, to the physically handicapped and infirm who find it awkward or impossible to attend an indoor theatre, to those who dislike parking problems. All of these people—as well as those who just enjoy the outdoors—are prospective Drive-In theatre patrons.

This large and entirely new field of patronage makes the Drive-In an unusually lucrative form of motion picture exhibition, not to mention the excellent concession business, which includes the sale of cigars and cigarettes, hamburgers, "hot-dogs," French fries, "cokes," and the usual popcorn and candy. Extra revenue can also be obtained from the operation of filling stations and restaurants on the premises.

Fred C. Matthews

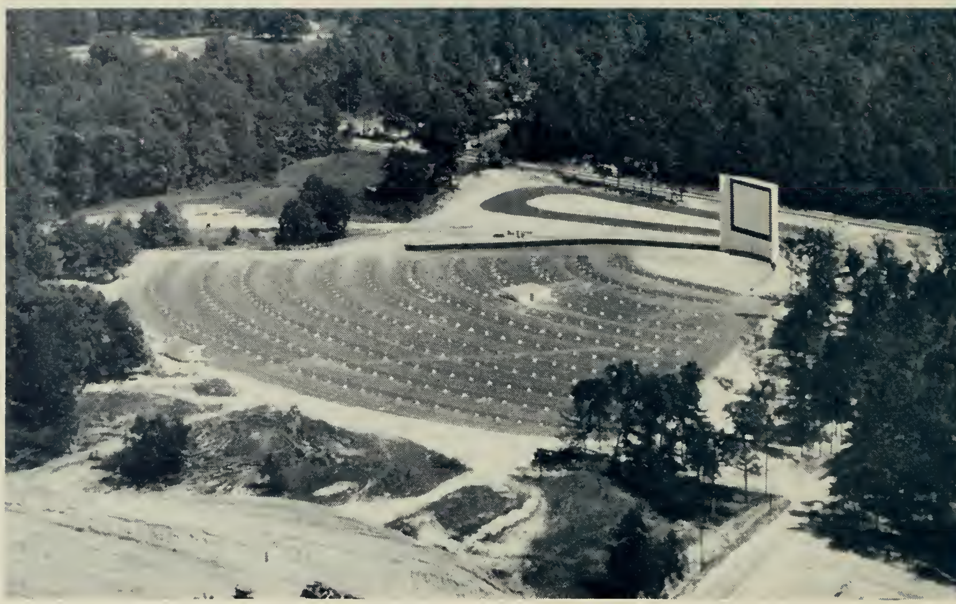
Selecting a Location

A good location is just as important to the successful operation of a Drive-In theatre as it is to an indoor one. There is more to be considered, however, than just the selection of a lot near a well populated area, for the topography of the lot itself radically affects the costs of construction. Following are some of the factors to be considered in the selection of a site for a Drive-In theatre.

1. It must be within easy driving distance of a population center of at least 50,000 people.

2. The lot should be on or adjacent to a well travelled main highway.

3. The Drive-In theatre should have a capacity of at least 500 cars in order to be a money making enterprise. The best layout for a theatre area of this size would be a lot at least 500 feet wide, and 600 feet deep. Each increase in capacity of 100 cars will require an additional 100 feet in width and fifty feet in depth. It will be observed that the site selected should be as nearly square as possible. Successful Drive-In theatres, however, have been built on irregularly shaped tracts of land, and a prospective irregular site should not be discarded until a scale layout has been made.



An attractive drive-in theatre—the Piedmont Avenue Drive-In at Atlanta, Georgia

4. Gentle slopes are generally desirable, since they facilitate drainage. A plot of land with widely varied elevations makes for heavy costs of drainage, grading and ramp construction.

5. Easy access to three phase electric power is important. If city water and sewer connections are adjacent to the lot, the cost of wells and cess-pools can be avoided.

6. Before the lot is purchased, by all means check with local zoning boards and traffic control authorities to make certain

that a Drive-In will be permitted on the site selected.

Factors When Building

Here are some important facts to bear in mind if it is your intention to build a Drive-In theatre.

First, obtain your capital requirements, as the majority of your investment will consist of financial "intangibles" such as grading, drainage, ramp construction, paving, wiring, fencing, water and sewer systems, and landscaping. Even the projection building, concession stand and screen tower are not good collateral for a loan, because of their highly specialized design. As sufficient capital must therefore be available in advance to cover the entire cost of the project, it is essential that an estimate of construction costs be obtained before proceeding with the project.

The cost of a modern Drive-In theatre equipped with in-car speaker systems exhibits great variance, due to such items as the location of the site with respect to water, sewage, and power and other utility lines. The varying requirements of the drainage system, grading and paving could easily show a difference in cost of as much as $40,000 between one site and another. Building construction costs will differ widely because of such factors as local labor conditions, the availability of materials, the building construction laws and ordinances of state, county or city, and, most important, your individual preferances as to size, appearance and type of construction of the screen tower and other buildings.

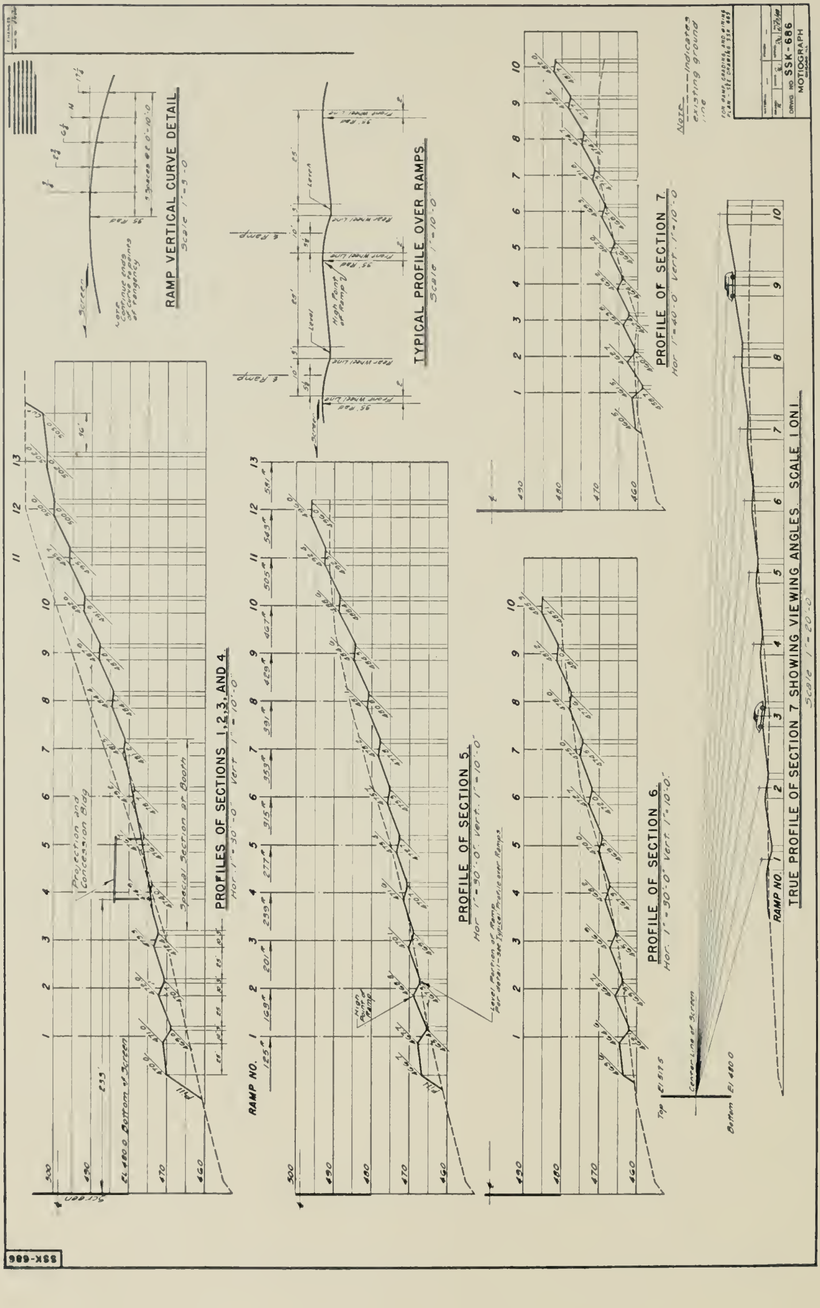
If the proposed site meets the major requirements listed previously, your next step is to secure an option to purchase for a sufficiently long period to obtain the necessary zoning permits. After these are secured, the purchase of the lot may be completed.

You should next obtain a local surveyor or civil engineer to make a topographical survey of the entire area, showing roads and existing grades, types of soil, unusual obstructions, and any other information, particularly with respect to drainage problems, that will be useful in the design of the theatre. It is also desirable to have ground borings made to determine how deep foundations will have to be laid in order that the screen tower will withstand the maximum wind velocity recorded in the vicinity of the Drive-In theatre.

This survey should be turned over to the civil engineer, architectural firm or company of your choice to make the layout of the desired size of theatre. The layout should give all necessary information as to drainage, grading and ramp construction, location of the screen tower, projection building, ticket booth, concession stand, parking area, roads, in-car speaker junction boxes, and wiring. Before construction is started, the layout should be checked carefully with state, county or city traffic authorities, who may insist on specifying the location and dimensions of entrance and exit drives and of parking areas, in order to accelerate incoming or to slow outgoing traffic. The projected drainage system usually requires the approval of city or county engineers, so that any change in the grade of the theatre area will not cause a serious drainage problem on adjoining property areas or highways.

After the theatre layout has been approved, you should secure plans for the screen tower, projection building, and concession stand, indicating to the planner the type of construction and the approximate extent of investment you wish to make in such buildings. Information will be presented later in this article on the requirements for selection of complete sound and projection equipment. Orders should be placed without delay for all necessary materials which are not supplied by the respective contractors, such as sound and lighting cables, and posts for junction boxes.

The first steps in the actual construction of the Drive-In theatre are the installation of the drainage system and the grading of entrance and exit drives and of the ramps



Profiles and viewing angles of typical Drive-In theatre

themselves. Some of the top soil removed from the theatre area may be set aside for landscaping purposes.

It is essential that wells, cess-pools, electrical, water and sewer, and other utility lines, along with the electrical lines to the junction boxes of the in-car speaker system, be in place before the lot is paved.

It does not matter whether construction begins with the screen tower, projection building or concession stand. The projection building usually is finished first, as many of the electrical connections and utility lines terminate within it.

The remaining steps are the completion of such projects as ticket booth construction, fencing and landscaping, the painting of buildings and fences, and paving.

Installation of projection room equipment and in-car speakers should be completed well in advance of the intended opening date, in order that complete tests and adjustments may be made. In advance of the opening, such items as concession room and ticket booth equipment and theatre supplies should be purchased, and signs and attraction boards installed.

Help to Builders

In building a Drive-In theatre, you really need competent advice from a civil engineer, a registered architect, and a theatre equipment specialist. Many architectural firms employ both civil engineers and architects who can give competent advice on the construction of a Drive-In theatre, except in those matters which pertain to theatre equipment. The very newness of the Drive-In theatre industry and the important relationship of sound and projection equipment to theatre layout and construction, has rendered it imperative for even the best architectural firms to call in the assistance of a theatre equipment specialist with practical experience in all phases of Drive-In theatre construction, equipment and operation.

Motiograph's engineers and equipment specialists have gathered together a great deal of specialized information on grading, ramp construction, the location of screen tower, projection building and concession stand, and the proper layout and equipment of a Drive-In theatre. This information is available to qualified persons.

Grading and Ramp Construction

Unless natural drainage is adequate during the entire theatre operating season, it is absolutely necessary that a drainage system be put in the theatre area before the lot is graded. The lot should be graded so that each car occupant can get a full view of the screen. This is accomplished by the construction of a series of semi-circular ramps centered about the screen.

Picture distortion and reduction of reflected light become worse toward the ramp end, and car positions 45 degrees away from a line perpendicular to the screen center are at the practical limit for reasonable satisfactory viewing conditions. Best modern practice confines the car positions within the sector extending not over 40 degrees on either side of the perpendicular. There is no absolute necessity for a symmetrical distribution of the car positions with respect to the screen, though where the lot topography permits, such a layout is obviously best from the standpoint of appearance.

Ramps should be approximately 38-40 feet apart, with the first ramp not less than 100 feet, but preferably 125 feet from the screen. The 38 foot minimum distance between ramps is necessary so that each car can enter or leave its ramp without interfering with the cars parked on the adjacent ramps. The back of each ramp should slope upwards toward the screen for about 18 feet to its highest point so that the tilt of the parked car will give the patrons in both front and rear seats a full view of the screen. The ramp must also slope forward from its highest point to its front so that the car may be driven away over the front of the ramp. The degree of slope from the back of each ramp to its highest point should increase as one ap-

proaches the screen so as to permit each patron the best possible view of the screen.

The best way to determine the necessary grades for each ramp is to secure a large scale elevation drawing of the entire theatre area and then plot the sight lines from the various ramp positions to the screen. Such a drawing is also useful in determining the maximum allowable heights of such obstructions as projection and concession buildings. Semi-circular construction of the ramps permits patrons located near the ends of the ramps to be close to the screen, and partially compensates for the poor viewing angles.

Ramps should allow at least 9 feet of space for each car. This amount permits easy access to the junction boxes of the In-Car Speaker Systems and helps to prevent collisions between cars and junction boxes. This spacing also allows access to each car by car hops and other theatre attendants. The number of ramps required depends upon the number of cars intended to be served. After grading has been done, ramps constructed, and junction box supports, wiring, sewage and water lines have been placed, the theatre area should be paved, preferably with a hard surfacing material.

It is recommended that lighted parking facilities immediately within the entrance to the Drive-In Area be provided to handle incoming cars in the period just before the early show nears its end.

Locating the Junction Boxes

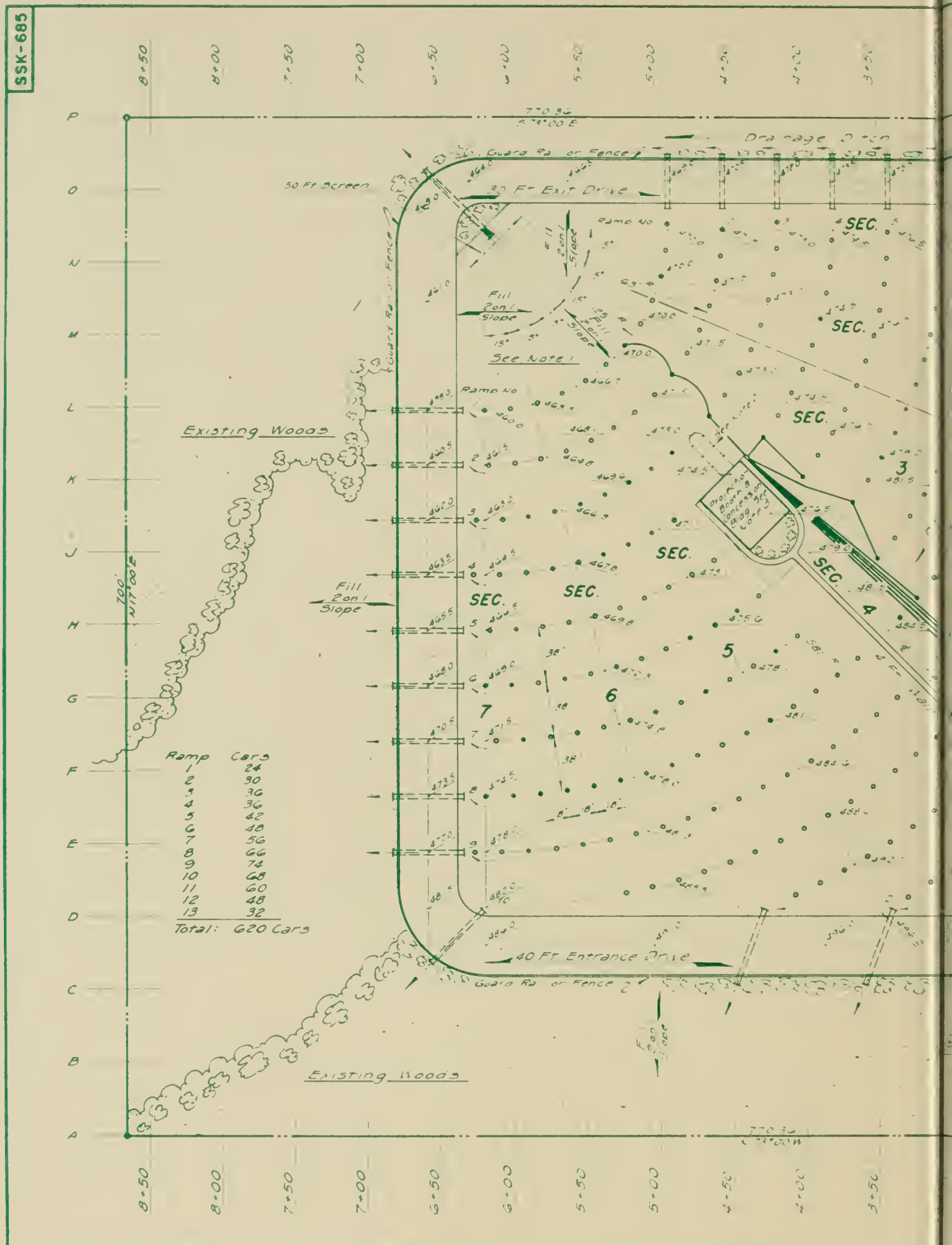
All in-car speaker systems require a junction box located between each two car positions along the ramps. These should be spaced 18 feet apart, about 5 feet back of the highest point of the ramp. Each junction box should be located on a wooden post or a pipe 40 inches above the ground, so that a car occupant can take an in-car speaker off the junction box without getting out of his car. The pipe mounting is more satisfactory, as the cables can be placed inside the pipe, making the installation more damage and weatherproof and imparting a better appearance to the theatre area. Pipe should be purchased 48 inches in length so that 40 inches of the length will be above the ground and 8 inches imbedded in a concrete base. The pipe should preferably be set in a suitable concrete base so that the support may better resist collisions and save damage to the junction box and speakers. Much cost and trouble may be saved in installation if the junction box selected is provided with a pipe connection fitting that does not require threading of the pipe.

Many junction boxes are designed for installation on a wooden post or upon a 2 inch diameter pipe and thus require the purchase of a pipe flange. As 2 inch pipe is not always available, Motiograph designed its junction box to mount on any sized pipe or tubing from 2 in. to 3½ in. outside diameter without the necessity for threading pipe or tubing or purchasing pipe flanges.

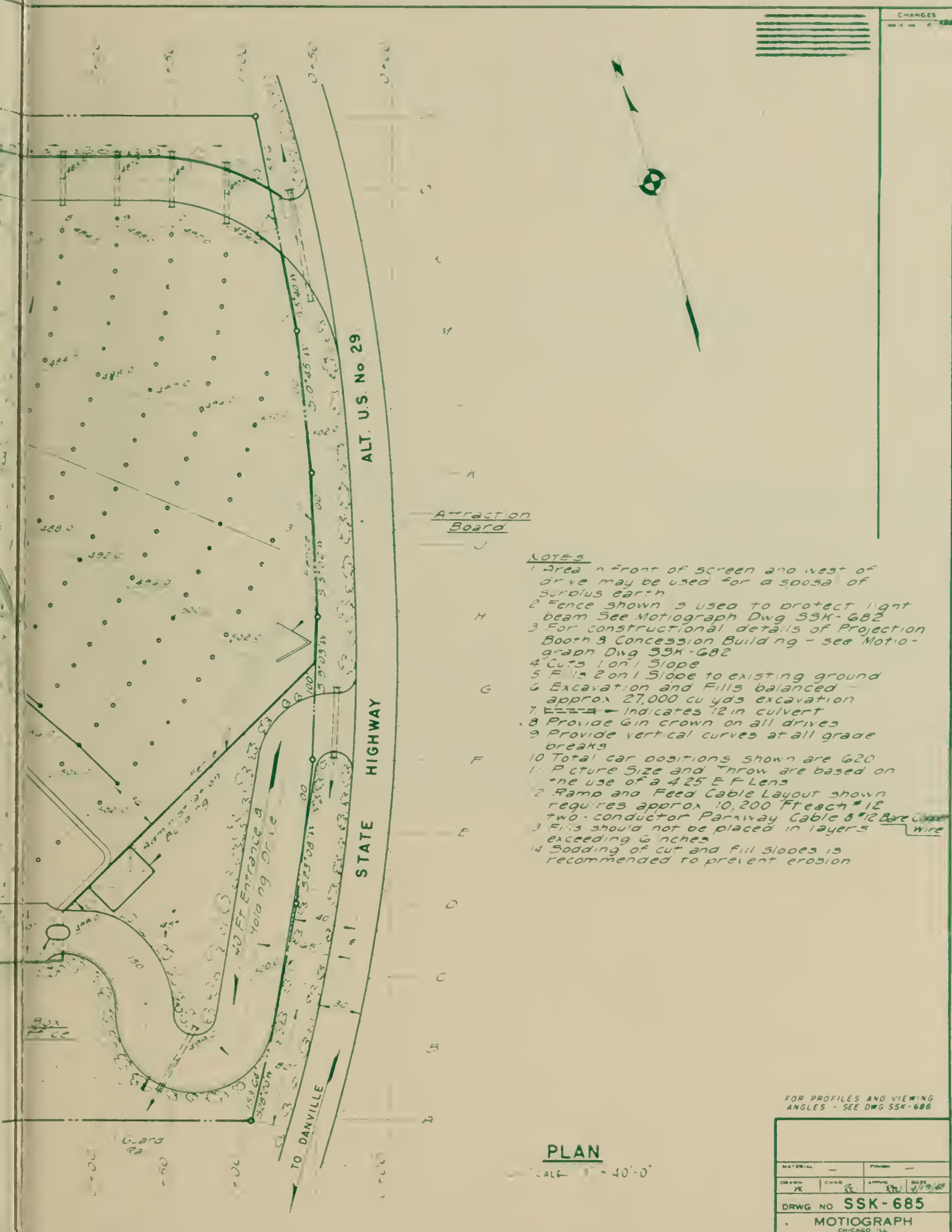
If the pipe support or junction box is provided with a lamp to illuminate the base of the speaker standard, it will enable the drivers more easily to guide their cars to the correct position on the ramps. This eliminates much damage to speaker equipment and automobiles and also permits use of a lighter block of concrete at each pipe support. Bases so illuminated may be numbered to assist patrons to find their cars, should they leave them.

Wiring System

Wiring costs in Drive-In Theatres using in-car speakers are relatively high because of the large amount of cable required to bring the sound circuits to each junction box. If lighting circuits are also provided to each junction point, still more cable is necessary, and it is hence desirable to use the type of cable which is least expensive to purchase and install. Experience indicates that two-conductor insulated underground cable of the "Parkway" type, buried approximately one foot below



Ramp, grading and wirin



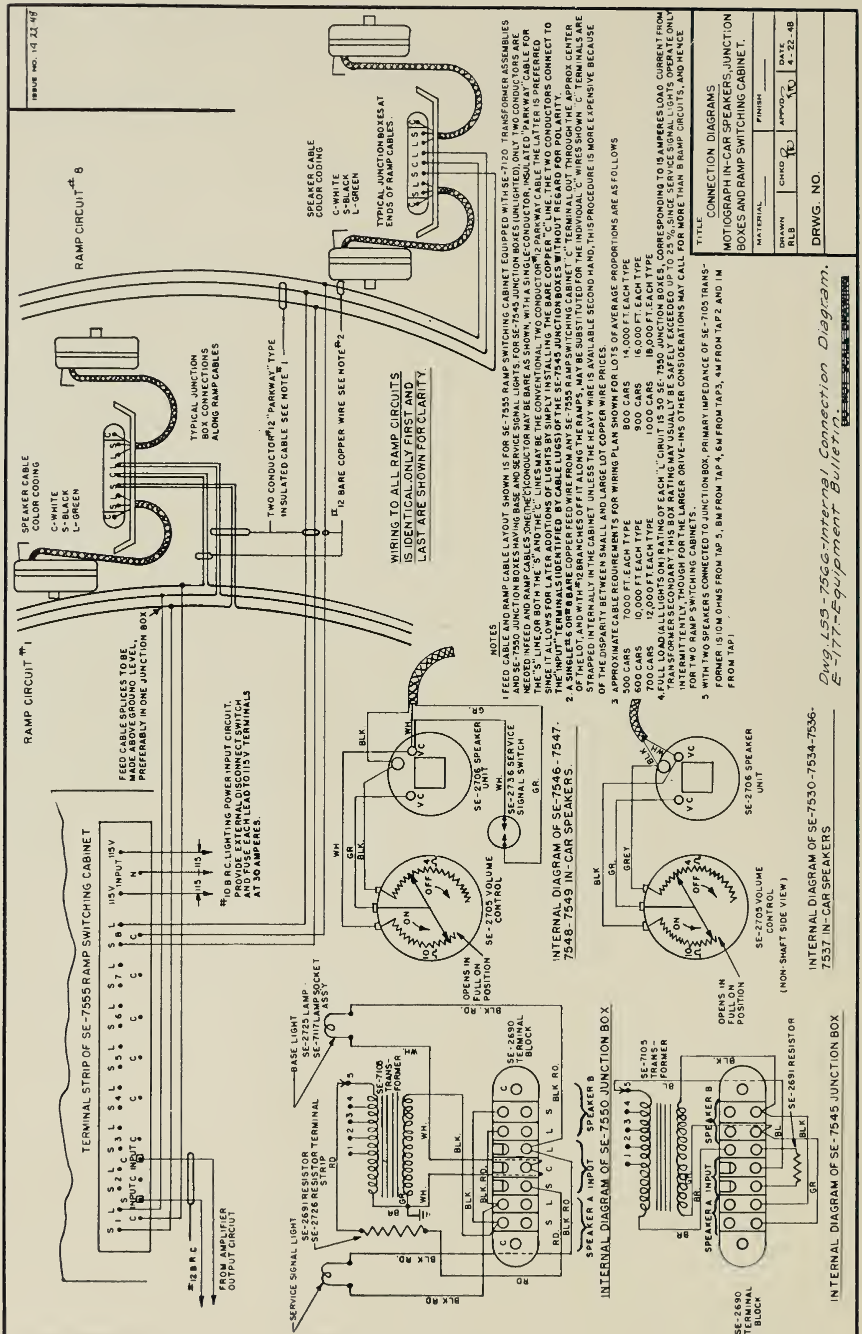
f typical Drive-In theatre

the lot surface and looped up into each junction box, most nearly meets the requirements. Along the ramps No. 12 or No. 14 wire is adequate in size and these sizes are also adequate for the feed cables to the ramps.

For unlighted junction boxes, both conductors are used for the sound circuit. For the new lighted Motiograph junction boxes, an additional un-insulated bare copper cable extending to each box provides a low-resistance common grounded return wire for both the sound and the low voltage lighting circuits. It may consist of a single No. 8 or larger cable from the projection building out to the approximate center of each ramp, with smaller No. 12 bare wires spliced on to run along the ramps and loop up into the junction boxes along with the insulated cable, or the No. 12 bare wires may run all the way back to the projection building along with the respective two-conductor insulated parkway feed cable for each ramp circuit. Electrically there is little difference, but the availability and cost of the heavy single ground line with its spliced-on branches may be a determining factor.

A drive-in theatre, showing a typical screen tower, and ramp construction which permits a clear view of the screen to patrons of all cars

It is advisable to divide the total number of junction boxes installed into a number of separate groups, with a feed cable from each group running to the projection building. Electrical arrangements in the junction boxes protect other boxes on the same feed line from being affected by accidental short circuits in speaker connection cords, but it is only by dividing the boxes into groups with separate feed cables that a measure of protection against short circuits in the feed cables themselves can be obtained. Such cable faults might arise from the accidental knocking down of a junction box support post, or by actual failure of cable insulation from one cause


ISSUE NO. 14 22 48
RAMP CIRCUIT #1
RAMP CIRCUIT #8
TERMINAL STRIP OF SE-7555 RAMP SWITCHING CABINET
115V INPUT 115V
#12 B R C
FROM AMPLIFIER OUTPUT CIRCUIT
FEED CABLE SPLICES TO BE MADE ABOVE GROUND LEVEL, PREFERABLY IN ONE JUNCTION BOX
#10 B R.C. LIGHTING POWER INPUT CIRCUIT. PROVIDE EXTERNAL DISCONNECT SWITCH AND FUSE EACH LEAD TO 115 V TERMINALS AT 30 AMPERES.
SPEAKER CABLE COLOR CODING
C-WHITE
S-BLACK
L-GREEN
TYPICAL JUNCTION BOX CONNECTIONS ALONG RAMP CABLES
TWO CONDUCTOR #12 "PARKWAY" TYPE INSULATED CABLE SEE NOTE #1
#12 BARE COPPER WIRE SEE NOTE #2
TYPICAL JUNCTION BOXES AT ENDS OF RAMP CABLES.
WIRING TO ALL RAMP CIRCUITS IS IDENTICAL. ONLY FIRST AND LAST ARE SHOWN FOR CLARITY.
SERVICE SIGNAL LIGHT
SE-2691 RESISTOR
SE-2726 RESISTOR TERMINAL STRIP
BASE LIGHT
SE-2725 LAMP
SE-7117 LAMP SOCKET ASSY
SE-7105 TRANS-FORMER
SE-2690 TERMINAL BLOCK
SPEAKER A INPUT SPEAKER B
INTERNAL DIAGRAM OF SE-7550 JUNCTION BOX
OPENS IN FULL ON POSITION
SE-2705 VOLUME CONTROL
SE-2706 SPEAKER UNIT
SE-2736 SERVICE SIGNAL SWITCH
INTERNAL DIAGRAM OF SE-7546-7547-7548-7549 IN-CAR SPEAKERS.
SE-7105 TRANS-FORMER
SE-2690 TERMINAL BLOCK
SE-2691 RESISTOR
INTERNAL DIAGRAM OF SE-7545 JUNCTION BOX
SE-2705 VOLUME CONTROL (NON-SHAFT SIDE VIEW)
SE-2706 SPEAKER UNIT
INTERNAL DIAGRAM OF SE-7530-7534-7536-7537 IN-CAR SPEAKERS
NOTES
1 FEED CABLE AND RAMP CABLE LAYOUT SHOWN IS FOR SE-7555 RAMP SWITCHING CABINET EQUIPPED WITH SE-7120 TRANSFORMER ASSEMBLIES AND SE-7550 JUNCTION BOXES HAVING BASE AND SERVICE SIGNAL LIGHTS. FOR SE-7545 JUNCTION BOXES (UNLIGHTED), ONLY TWO CONDUCTORS ARE NEEDED IN FEED AND RAMP CABLES; ONE (THE "C") CONDUCTOR MAY BE BARE AS SHOWN, WITH A SINGLE-CONDUCTOR, INSULATED "PARKWAY" CABLE FOR THE "S" LINE, OR BOTH THE "S" AND THE "C" LINES MAY BE THE CONVENTIONAL TWO CONDUCTOR #12 PARKWAY CABLE THE LATTER IS PREFERRED SINCE IT ALLOWS FOR LATER ADDITIONS OF LIGHTS BY SIMPLY INSTALLING THE BARE COPPER "C" LINE. THE TWO CONDUCTORS CONNECT TO THE "INPUT" TERMINALS (IDENTIFIED BY CABLE LUGS) OF THE SE-7545 JUNCTION BOXES WITHOUT REGARD FOR POLARITY.
2. A SINGLE #6 OR #8 BARE COPPER FEED WIRE FROM ANY SE-7555 RAMP SWITCHING CABINET "C" TERMINAL OUT THROUGH THE APPROX CENTER OF THE LOT, AND WITH #12 BRANCHES OFF IT ALONG THE RAMPS, MAY BE SUBSTITUTED FOR THE INDIVIDUAL "C" WIRES SHOWN "C" TERMINALS ARE STRAPPED INTERNALLY IN THE CABINET UNLESS THE HEAVY WIRE IS AVAILABLE SECOND HAND, THIS PROCEDURE IS MORE EXPENSIVE BECAUSE OF THE DISPARITY BETWEEN SMALL AND LARGE LOT COPPER WIRE PRICES.
3 APPROXIMATE CABLE REQUIREMENTS FOR WIRING PLAN SHOWN FOR LOTS OF AVERAGE PROPORTIONS ARE AS FOLLOWS
500 CARS 7000 FT. EACH TYPE
600 CARS 10,000 FT. EACH TYPE
700 CARS 12,000 FT. EACH TYPE
800 CARS 14,000 FT. EACH TYPE
900 CARS 16,000 FT. EACH TYPE
1000 CARS 18,000 FT. EACH TYPE
4. FULL LOAD (ALL LIGHTS ON) RATING OF EACH "L" CIRUIT IS 50 SE-7550 JUNCTION BOXES, CORRESPONDING TO 15 AMPERES LOAD CURRENT FROM TRANSFORMER SECONDARY THIS BOX RATING MAY USUALLY BE SAFELY EXCEEDED UP TO 25%, SINCE SERVICE SIGNAL LIGHTS OPERATE ONLY INTERMITTENTLY, THOUGH FOR THE LARGER DRIVE-INS OTHER CONSIDERATIONS MAY CALL FOR MORE THAN 8 RAMP CIRCUITS, AND HENCE FOR TWO RAMP SWITCHING CABINETS.
5 WITH TWO SPEAKERS CONNECTED TO JUNCTION BOX, PRIMARY IMPEDANCE OF SE-7105 TRANS-FORMER IS 10M OHMS FROM TAP 5, 8M FROM TAP 4, 6M FROM TAP 3, 4M FROM TAP 2 AND 1M FROM TAP 1
TITLE
CONNECTION DIAGRAMS
MOTIOGRAPH IN-CAR SPEAKERS, JUNCTION BOXES AND RAMP SWITCHING CABINET.
MATERIAL
FINISH
DRAWN RLB
CHKD
APPVD
DATE 4-22-48
DRWG. NO.
Dwg. LS3-7566-Internal Connection Diagram.
E-177-Equipment Bulletin.
[redacted]

or another. With separate cables and suitable switching facilities in the projection room, the affected group can quickly be isolated, with very little overall loss of show time.

An ideal arrangement is a separate feed cable for the car positions along each ramp. Another possible arrangement which has much merit is to divide the lot up into sectors containing approximately 50 junction boxes (100 speakers); this requires more radial ditches for feed cables, but allows the extreme side sectors, which fill up last and are the least used, to be shut off when they are unoccupied. At least four, and preferably six to eight, groups should be provided for Drive-In Theatres in the 500 to 800 car class.

The feed cables from each group of junction boxes should terminate in the projection room in a suitable switching cabinet or panel board. Switching facilities can be constructed on the job during installation of the sound and projection equipment, but the prefabricated ramp switching cabinet greatly simplifies the work and provides not only the switching, but also individual ramp circuit sound monitoring.

The outside of the screen tower serves admirably for advertising and decorative purposes

The Screen Tower

The most important consideration in locating the screen tower is to have the screen facing north or northeast so as to lengthen the available show time as much as possible. Most Drive-In Theatres have the screen tower located near the public road so that incoming traffic may be regu-

lated and tickets sold and collected at offices in or adjacent to the screen tower itself.

The vicinity adjacent to the screen tower, entrance and exit to the theatre proper, should be landscaped and well lighted; directional signs should be placed at or near the entrance to accelerate the flow of traffic. Exit drives in particular should be as wide as the highway authorities will allow, so as to facilitate rapid emptying of the lot after the first show. Auxiliary exits are also desirable to help clear the theatre area. The use of flood lights located on the screen tower will also aid in the flow of outgoing traffic. Attraction boards announcing the night's attraction should be placed where they can be seen from both directions.

We suggest consideration of building the screen tower in a triangular shape so that one side will face the traffic coming from one direction while another side faces the opposing traffic. This permits the placement of large well lighted signs, thus allowing the name of the theatre to be seen for a considerable distance in two directions.

The minimum picture size recommended is 30 feet high by 40 feet wide, which would be satisfactory for up to 10 ramps. The width of the screen should be increased about 5 feet for each additional ramp constructed, but the maximum width should not exceed 55 feet if a reasonably well lighted screen image is to be obtained. The picture height is approximately three quarters of the picture width. In order to give each patron a clear view of the screen, it is necessary to have the bottom of the screen from 16 feet to 25 feet above ground level so that patrons in cars on one ramp may see over the cars in the ramp ahead.

The screen itself should preferably be constructed of large flat weather-proof panels painted with a flat white paint. While joints and seams are not too noticeable when the picture is projected, a better picture will result if the joints of the panels are sealed. Masonry towers may have screen surfaces of panels as described, though good results may also be obtained by constructing the screen surface of cement plaster, painted with flat white weather proof concrete paint.

To obtain maximum light reflection into the parking area, and to reduce "keystone effects," it has been recommeded that the face of the screen should be tilted forward into the parking area, so that a perpendicular line from the screen center would terminate approximately two-thirds the depth of the theatre from the screen face. The slightly improved picture results observed to date from following this procedure are not justified if it causes any large increase in screen building costs.

A shadow-box has proved to be helpful in preventing extraneous light from shining on the screen. It is questionable, however, if the benefits gained warrant the extra construction expense.

The screen building may be of structural steel construction. Cement block construction reinforced with steel bars, and wooden structures anchored to telephone poles, have been used to good advantage in many instances. The screen tower must, however, be constructed to withstand maximum wind velocity in the area in which it is to be erected.

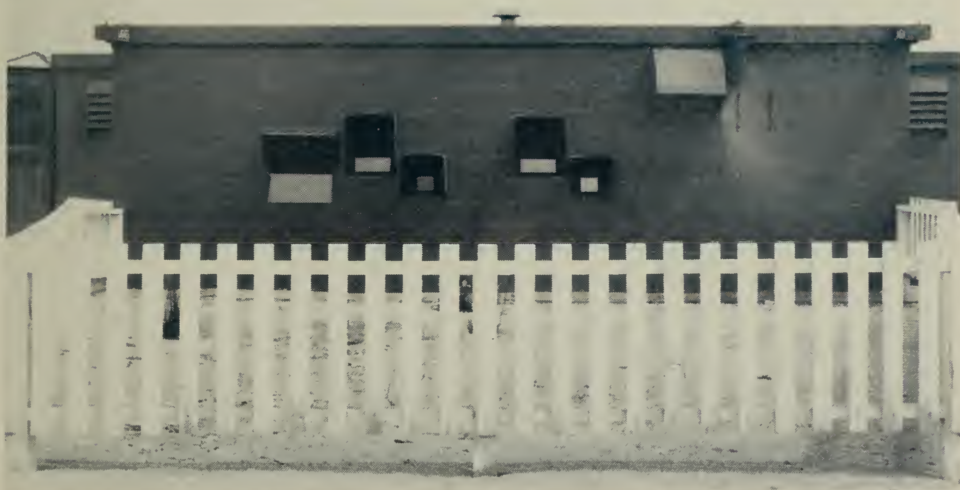
Projection Room

The most efficient projection lenses currently available are the high-speed, anti-reflection-coated types and we recommend such lenses to the exclusion of all other types. Even in these excellent lenses, however, there is considerable variance in the degree of efficiency and amount of distortion offered in their varied focal lengths. Experience has shown that the best overall performance is given by 4 in. to 4½ in. lenses, with 4¾ in. and 5 in. lenses being slightly less efficient. The use of lenses of these focal lengths automatically requires that the Drive-In Theatre projection build-

ing be located at least 200 feet from the screen if a large picture is to be obtained.

The exact distance from screen to projection building is dependent upon the size of the picture desired and the necessity of using lenses in the 4 in. to $4\frac{1}{2}$ in. range. To obtain the correct throw (the linear distance from the screen center to the lens center) one should multiply the picture width by the size of the lens and then divide the result by 0.825, i.e., with a picture width of 40 feet desired and with a $4\frac{1}{4}$ in. lens to be used, the formula is 40 times $4\frac{1}{4}$ divided by 0.825 or 206 feet.) The distance on the ground from screen to projection building will be slightly less than the length of throw.

The projection booth should follow the same plans as those of an indoor theatre with respect to location of the projection equipment. It is important that the building be as low in height as possible so that an absolute maximum of car locations behind the building may be utilized. It has been recommended that part of the building be located below ground, but actual practice has shown that the losses caused by water seepage are considerably greater than any extra revenue that might be obtained from the gain of a few car positions. It is important that the foundations and lower walls of the projection building be fully sealed against moisture.



Front of the projection building of a Drive-In theatre. The white fence serves to guard against interference

In addition to the projection booth, space should be provided in the projection building for a power equipment room and men's and women's washrooms. These rooms must be adequate in size, but it should be borne in mind that the larger the building, the more the loss of favorable car positions on adjacent ramps.

The Concession Stand

In most Drive-In Theatres the concession stand is located almost directly behind the projection building, so that water, electricity and sewer lines may not have to be run a long distance. A roofed-in area

between projection building and concession stand helps concession business in rainy weather.

Paving

Paving of the theatre area is desirable for a number of reasons. A paved area makes it easier to drive and walk, eliminates dust, and helps drainage. Most important, paving keeps the original contour of the ramps, thus maintaining perfect sight lines from all positions.

Obviously, cost of paving will vary widely depending upon the type of paving selected, soil conditions at the particular site and the size of the theatre and parking area. The most economical and satisfactory surfacing is one consisting of hard aggregate spread on after a binding coating of light oil has been applied on the subgrade. The hard aggregate should then be rolled to the established grades and coated with a heavy asphalt bearing oil. A second layer of aggregate and oil should then be applied, after which a light sand can be brushed over the entire surface.

The above specification is general, of course, as the size and amount of aggregate to be used depends upon local soil and other conditions.

Estimated Construction Cost

Construction costs of Drive-In theatres are governed by a great many variable factors, and therefore differ considerably. The following figures are of course only estimated, but are probably very close to the minimum requirements for a theatre of 500 car capacity with in-car speaker equipment.

Drainage System	$ 2,500.00
Grading and Ramp Construction	8,000.00
Water and Sewer Systems	3,000.00
Projection Building (including plumbing)	5,500.00
Concession Stand and Equipment	4,500.00
Paving (including parking area)	15,000.00
Electrical Wiring and Fixtures	5,000.00
Screen Building	12,000.00
Posts for Junction Boxes	1,000.00
Lights for Junction Box Supports	2,500.00
Projection and Sound Equipment, with Speakers	19,500.00
Ticket Office and Equipment	1,250.00
Fencing	3,000.00
Landscaping	1,750.00
Advertising Signs	3,000.00
Miscellaneous Labor	2,500.00
Cost of Plans and Specifications	5,000.00
Total	$95,000.00

As previously mentioned, this estimate of $95,000.00 may vary considerably because of localized and specialized factors.

Drive-In Theatre Equipment

The construction of many hundreds of new Drive-In theatres is now being planned or contemplated in the United States and Canada. Most of those which are built will no doubt be successful, but the best located, the best managed and the best equipped are sure to stand out as the best profit producers when competition for the movie goer's dollar becomes more intense.

Equipment, in fact, plays a highly important part in the success of any Drive-In theatre. There are very special requirements for equipment of the Drive-In, and we therefore intend to devote considerable space to a discussion of those requirements.

Sound Equipment

Experience has indicated that the Drive-In theatre sound system is the most important single item of equipment to be selected. The Drive-In exhibitor not only has to consider the quality of reproduction in

his sound system, but also such factors as the preferences of his customers as to type of speaker equipment, and the proximity of neighbors who might be disturbed.

Early Drive-In theatres employed either a central loudspeaker system, or individual speakers mounted upon posts so that the sound could be heard by the occupants of the car on either side. Both methods were found wanting. In order to secure a sufficient flow of patronage, it was necessary to locate within the vicinity of population centers, and any speaker system which was loud enough to serve an outdoor theatre was also loud enough to cause the neighbors to obtain an injunction against it as a public nuisance. The post type speakers served to cut down some of the objectionable noise volume, but they required that the windows of the car be kept open, which often proved uncomfortable in chilly or rainy weather.

As a result, very few of the older Drive-In theatres, and an even lesser number of the newer ones, are employing either of these methods of sound reproduction, in spite of their considerably lower initial cost. The possibility of having the Drive-In closed by injunction, which would mean the substitution of an entirely new system of sound reproduction or the abandonment of the enterprise, is far too much of a gamble for most exhibitors.

In-Car Speakers

The trend has therefore been strongly to In-Car speakers. The sound volume may be regulated as the patron desires, and the windows of the car may be kept closed in unfavorable weather.

It is true that in-car speakers have not always proved eminently satisfactory in some installations. This disappointment has been due principally to the employment of speaker units of poor quality and of insufficient size to reproduce the sound in an acceptable manner. As a consequence, Motiograph recommends the use only of high quality speaker units not smaller than the standard five inch type. While chief consideration in the selection of speakers should be based on sound quality, with some consideration being given to appearance and convenience in handling, it is important to bear in mind that the speakers are often subjected to some very rough handling on the part of the patrons, and therefore the longevity and durability of components, mechanical design and construction, and facility of repair, are items which should also be given a due share of attention. Weather proofing also plays a part in reducing annual maintenance costs, and should be duly calculated when figuring initial expense and total overall cost.

In-car speakers are connected to the junction box by three different types of cords. The most popular and the least expensive of these is a regular rubber covered cable. Another is a coiled cord, which costs more per speaker. A third type consists of the regular rubber cable with a companion steel cable, both covered with a waterproof casing, and is considerably more costly than either of the other two.

These types of cords have their particular advantages and disadvantages. Experience has shown that the regular rubber cable hanging down from the junction box sometimes catches on automobile bumpers or door handles. This can be eliminated to some extent by utilizing a coiled cord. The steel cable type of connection cord virtually eliminates the loss of in-car speakers through theft, but when an absent minded driver starts off without removing the speaker from his car, the resultant damage may be considerable.

Junction Boxes

Each two in-car speakers require a junction box, in which is located an impedance matching transformer. A very careful check of this unit should be made before purchase, as much operational difficulty can be avoided if a well designed unit with good components is selected. Here are the requirements which a prospective pur-

chaser should look for in a good junction box.

1. It must be as weather proof as it is possible to make it.

2. It must be strong.

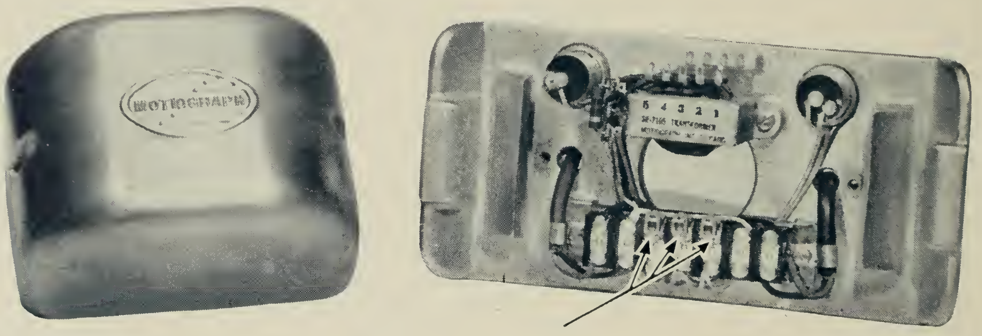
3. Terminal blocks must be supplied for the speaker and feed cables.

4. Impedance matching transformers should be of the highest quality. (Check to see that they are fully impregnated against the effects of moisture.)

9. The junction box should present an attractive appearance, since it is in the full view of the patrons.

Power Requirements

The sound system must have power amplifiers sufficient to provide one-quarter of one watt of power for each in-car speaker. A Drive-In theatre with a 600 car capacity would thus require a sound system with a minimum of 150 watts of power.



Motiograph SE-7550 In-Car Speaker Junction Box, with interior view to show light sockets, terminal block and adjustable impedance matching transformer. Arrows indicate ramp cable lugs

5. Speaker hooks must be well designed to permit the patron to replace the speakers quickly on the junction box, and they should be rubber plated so they will not scratch or mar the automobile when in use.

6. Electrical circuits should be so arranged as to prevent accidental short circuits in speaker connection cables from affecting other junction boxes on the same ramp feed circuit.

7. The junction box should be designed to allow easy and rapid servicing, and the mounting facilities should permit the boxes to be readily removed for inside storage at the close of the Drive-In season.

8. Speaker support hooks should be an integral part of the box, so that it will not be necessary to drop speakers on the ground to inspect connections and do other testing.

Under no circumstances should the Drive-In theatre owner select a sound system with an amplifier power output of less than one-quarter of one watt for each in-car speaker.

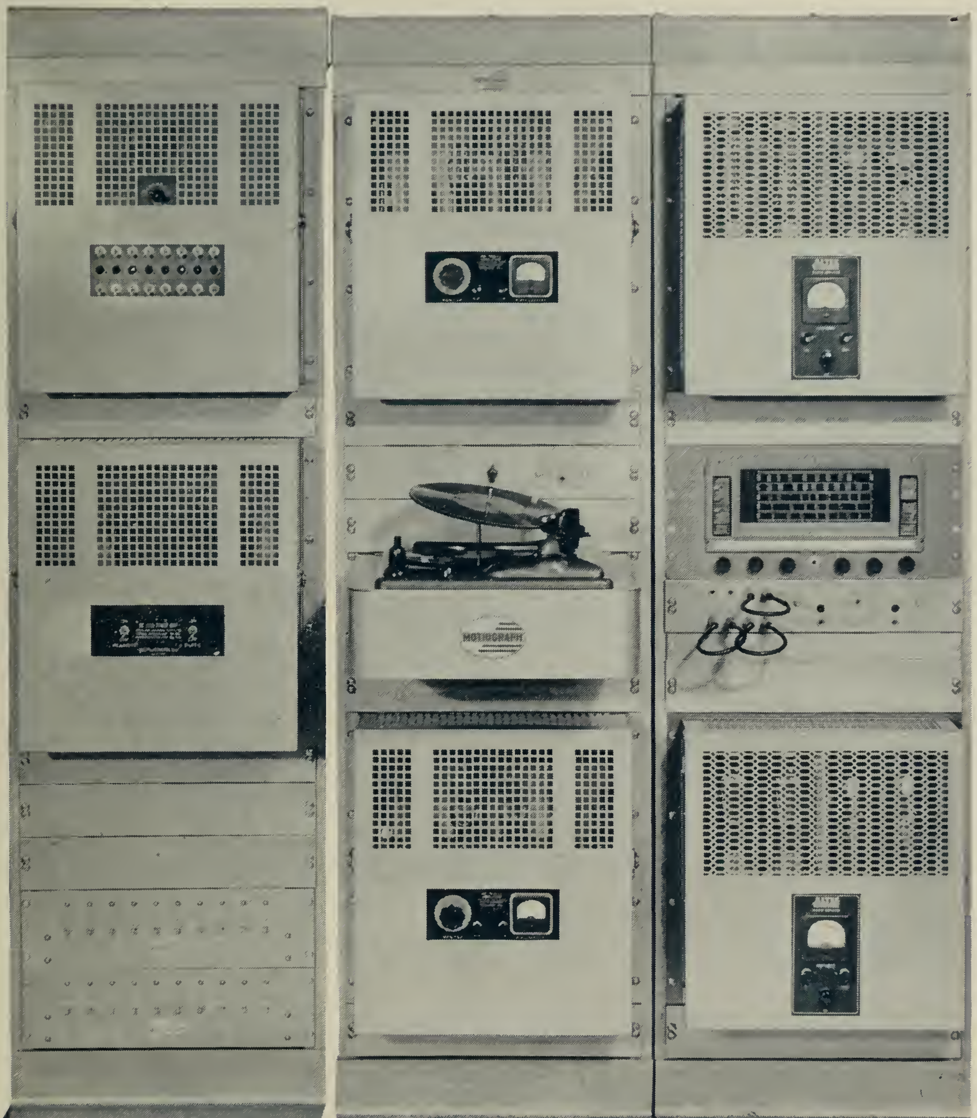
Emergency power amplifiers can be obtained for only a slightly greater investment, and it may therefore prove desirable to select a dual amplifier system. The refunds from a single full show will pay for the additional cost.

Projection Equipment

The screen of the Drive-In theatre must be a large one (30 feet x 40 feet or more, depending upon the size of the theatre). It is therefore absolutely necessary to select a combination of projection equipment that will give maximum screen illumination.

Projection Lenses

It has been proven from thousands of installations in both indoor and outdoor theatres that anti-reflection coated lenses transmit a greater portion of the available light than do lenses of the uncoated variety. As



Motiograph sound equipment racks for large Drive-in theatres.

the greater dimensions of Drive-In theatres present an increased lighting problem, it is absolutely essential that coated lenses be employed.

Arc Lamps

The best type of high intensity arc lamps for Drive-In theatres is the subject of a great deal of contention between the manufacturers of condenser-type high intensity arc lamps burning in the 140/180 ampere range, and the manufacturers of reflector-type arc lamps operating in the 65/115 ampere range.

It appears from tests that have been made, that reflector-type lamps operating at 70 amperes and condenser-type lamps operating at 140 amperes produce approximately the same amount of light on the screen, other conditions being equal. If the tests mentioned may be regarded as accurate, it would appear that condenser-type lamps should give somewhat more light when operated at 180 amperes.

It is to be noted, however, that if condenser-type lamps are operated above 140 amperes that a glass or quartz filter is usually required between lamphouse and projector mechanism to prevent damage to the film from the intense heat. Obviously such a filter causes a light loss which in large measure offsets the gain in light from the higher current. (See the Journal of the Society of Motion Picture Engineers, Vol. 45, No. 2, August, 1945.)

It is to be noted that the larger the current rating of arc lamps, the greater is the initial cost of both the lamps and their power supplies. The operating costs for reflector-type lamps are radically lower than those for condenser type lamps due to much lower carbon costs, cheaper optical elements, and lower power requirements.

We recommend reflector-type arc lamps operating at 70 amperes for Drive-In theatres with up to 46-foot screens, and reflector-type arc lamps burning at 85/115 amperes for Drive-In theatres with screens of a greater width. The latter lamps will give greater screen illumination than can be obtained from any other type of high intensity arc lamp. The use of auxiliary blowers on the projectors dissipates excess heat at the projector aperture.

Arc Lamp Power Supply

The selection of the arc lamp power supply is largely a matter of individual preference. Whether the motor generator set, with higher initial but lower operating cost, or rectifiers, with lower initial but higher operating cost, are selected, it is important that they have sufficient capacity to operate the arc lamps at maximum amperage.

The Projector Mechanism

All of the useful light which reaches the screen from the arc lamps must pass through the projector mechanism. The light produced by the arc lamps, however, cannot reach the screen all of the time, because of the shutter of the projector mechanism.

It is the function of the shutter alternately to permit light to fall on one frame of the film for a fraction of a second, and then block out the light for a fraction of a second while the next picture is brought into place. The shutter is absolutely necessary, for without it the series of pictures on the film would contain numerous disconcerting streaks of light. As it is, the alternate light and dark periods permit each picture to stand out clearly on the screen.

Therefore, it is necessary not only to select the lamps, power supply and lenses best suited to the needs of a Drive-In theatre, but also a projector which permits the maximum amount of light emitted by the arc lamps to reach the screen when the shutter is open.

Motiograph, like other leading American manufacturers of projectors, strongly recommends double shutter mechanisms over single shutter models. When double shutter mechanisms are employed, there are two blades simultaneously cutting the light beam from opposite directions. The time required to cut the light off the screen and

Motiograph SE-7550 In-Car Speaker Junction Box, mounted on pipe, and showing base (left) and service signal lights. Speakers illustrated are Motiograph SE-7548 (left) with blue enamel finish and coiled cord; and SE-7547, with brushed cadmium finish and straight cord

restore it is thus reduced by one-half as compared with the single shutter, and the screen receives a proportionately increased illumination.

In-Car Speaker Equipment

The Motiograph in-car speaker is sturdily constructed to withstand rough weather and rough handling. The speaker unit is weather proofed, and the steel housing is bonderized and finished in baked enamel or brushed cadmium with a final clear lacquer finish. Speaker hooks are rubber plated for automobile protection.

For ease of maintenance, the in-car speakers may be quickly disassembled, although patented screws are utilized to discourage patrons from attempting to take them apart with a coin, knife or ordinary screw driver. A brass splash screen is placed immediately behind the perforated front of the speaker housing, and keeps patrons from inserting sharp instruments through the perforations and into the speaker unit, as well as preventing driving rain or insects from reaching the speaker unit cone.

The speaker units are designed to have large safety factors, both mechanically and

electrically. Welded magnetic structures and heavy duty Alnico V permanent magnets give extreme ruggedness and high efficiency.

Individual speaker volume controls are of the constant impedance type, and amplifier loading remains the same regardless of control settings. This factor insures optimum amplifier performance, and eliminates the necessity for constant readjustments of sound system fader settings as the number of speakers in use changes.

The control knobs are machined from solid aluminum for strength and appearance, while the controls are supported by the brass splash screens and thereby cushioned against mechanical damage.

Speaker cables are provided with spade terminal lugs which make for ease of installation, quick changes of speakers, and reduced costs of installation and replacement.

In-Car Speaker Essentials

It is highly important to the Drive-In theatre owner that he select the correct make of in-car speaker.

A listening test would be desirable, for no precaution is superfluous when the matter of good sound reproduction is concerned. As the novelty of an outdoor theatre disappears, the Drive-In patrons will tend to become more and more critical of sound quality.

Though a small speaker may be compact and pleasing in appearance, its very smallness limits the size of the speaker unit. This in turn limits the low frequency response, and results in lowered fidelity of voice and music reproduction. A smaller speaker also requires more power to attain equal loudness.

High frequency response constitutes a direct measure of speech intelligibility. Perforations instead of louvres in the face of the speaker housing permit more direct sound radiation. Louvres tend to obstruct the higher frequency sounds, resulting in a hollowness of tone.

Junction Boxes

The Motiograph SE-7545 junction box is made from two aluminum castings. It is consequently rust proof, and requires no periodic painting to maintain its attractive appearance. The top casting covers the impedance matching transformer and terminal block for the speaker and feed cables. The lower base casting fits the post support, and has two integral sturdy speaker hooks which permit the replacement of the speakers after use. This location of the speaker hooks permits access for servicing of the transformer, terminal block and speaker and feed cables without the necessity of dropping the speakers on the ground.

The two castings of the junction box are joined tightly together by two strong and readily accessible bolts, making a completely weather proof enclosure for the transformer and terminal block, and yet one which can be quickly and easily opened for servicing.

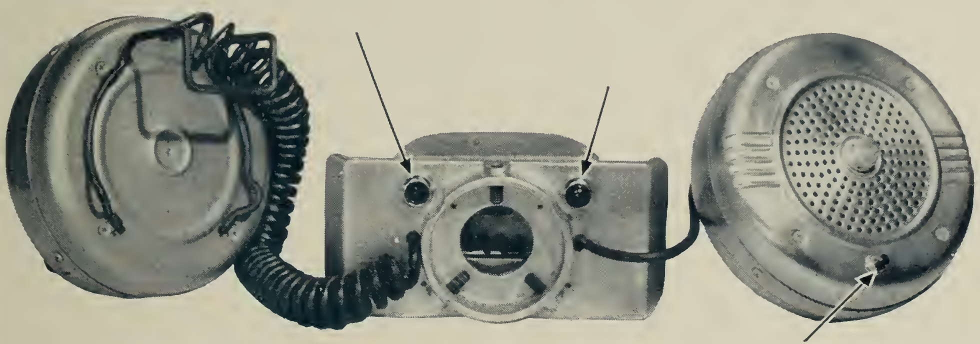
The junction box contains an impedance matching transformer of the highest quality, fully impregnated against the effects of moisture. The transformers have multitapped primary windings so that any required number of junction boxes may be connected to give the proper feed line impedance for optimum amplifier performance. The electrical circuits of the box are so arranged as to prevent accidental short circuits in speaker cables from affecting other junction boxes on the same ramp feed circuit.

Junction Box Lights

Experience has demonstrated that it is desirable to illuminate the base of each speaker standard. Such a light enables drivers more easily to guide their cars to the correct position on the ramps, and thus eliminates much damage both to speaker equipment and to automobiles. This decreased risk of damage also permits the use of a lighter block of concrete at each pipe support. The bases may be numbered, in

order to assist patrons to find their cars more easily should they leave them.

Another advantage of post lights is that they enable the patron to see to remove or replace the speakers. This not only makes for the convenience of the customer, but eliminates a source of damage to the speakers through their being permitted to fall to the ground.



Under view of Motiograph SE-7550 In-Car Speaker Junction Box, with Speakers SE-7548 and SE-7547, to show base (left) and service signal lights on junction box, and arrangement for mounting on unthreaded pipe or tubing. Arrow on right hand speaker indicates service signal pushbutton switch

Post lights greatly enhance the beauty of the Drive-In theatre. The illuminated lines of the ramps present a picturesque appearance, and render lights unnecessary at the ends of the ramps.

The sales of concessions may be increased materially if the patron is able to signal the concession attendants without leaving his car. Such a signal system furthermore eliminates the need for car solicitation, as many people do not wish to be disturbed by car hops when they are not disposed to buy.

To provide for both a lighted post and a means of signaling a concession attendant, Motiograph furnishes a version of its junction box with a white light to shine down upon the junction box support, and a red light to signal the car hop.

The post lights are operated from the projection building. The concession light may be turned on and off by the patron while inside his car by operating a switch on each speaker, and cause the red light to flash or to burn steadily until the switch is turned.

Current for the lights is furnished at approximately 30 volts from step-down transformers in the projection room by way of low voltage ramp lighting feed circuits which have one grounded conductor in common with the grounded side of the sound feed circuit. The lighted junction boxes therefore require only a single uninsulated bare copper wire to each box position, in addition to the usual two-conductor insulated parkway cable. The relatively low lamp supply voltage meets the safety requirement of the National Electric Code without the necessity for separate standard voltage lighting circuits to each box position. The amount of light produced by the base and signal lights is sufficient for their respective functions, but not great enough to cause glare conditions which might interfere with picture visibility.

Power Supply Equipment

For those desiring prefabricated ramp

circuit switching facilities, Motiograph offers a cabinet design matching other projection room sound system components. Heavy duty terminals are provided for the incoming ramp circuit cables, and the on-off switches are of the very reliable toggle-type developed for aircraft duty. The switching circuits are arranged so that as circuits are turned off, suitable substitute loading resistors are connected in their place, and amplifier performance thus remains the same regardless of the number of speakers in use. The cabinet houses a small monitor speaker, and the electrical circuits to this speaker include a rotary tap switch to permit it to be connected to any one of the outgoing ramp circuits. The projectionist thus can individually monitor the ramp circuits without leaving the projection building, and instantly detect and turn off a circuit which might be in trouble due to accidental damage to the feed cables. As the ramp circuit monitor speaker is of the same type and relative efficiency as the in-car speaker units, it allows volume levels in the feed lines to be adjusted properly for best performance. The standard cabinet provides eight individual ramp circuits, and is thus suitable for use in all except the very largest Drive-In theatres, which require two cabinets.

A special version of the ramp switching cabinet includes the necessary power supply transformers for junction boxes having base and service signal lights. The cabinet mounts a maximum of eight individual ramp circuit lighting power transformers, each capable of supplying a group of approximately fifty boxes under full lighting load conditions. The transformers are supported by an angle iron chassis having a hinged door on the cabinet cover side. Each transformer has its own primary fuse for wiring and transformer protection, and the standard 115 volt primary circuits to each transformer include individual switches mounted on the hinged door adjacent to the sound circuit on-off switches so that the lighting portion of the associated ramp feed circuit can likewise be turned on or off. Low voltage pilot lamps of the same type used in the junction boxes illuminate red jewels adjacent to the light switches, and thus provide continuous monitoring of the power circuits to the junction box lights. Switches and jewels are grouped so that they extend through the cutout portion of the cabinet cover. Transformer windings are provided with sufficient taps to permit the delivered voltages at the junction box lights to be adjusted correctly, taking into account the varying line losses between close-in and outlying ramp circuits, which would not be possible with a less flexible transformer design. With individual transformers, furthermore, accidental cable faults affect only the one lighting circuit concerned—an important operational safety factor. If desired, ramp switching cabinets may be mounted on the amplifier racks, although it is usually more convenient to mount them on the projection room wall, just above the point where the ramp cables enter.

TELEVISION

Theatre Television

A Survey of Its Prospects

By HARRY DONALDSON

There is no doubt about it—the motion picture exhibitors of the country are manifesting a keen interest in the subject of television. This interest lies not so much in the still somewhat complicated technical aspects of television, but rather as to how much home television might adversely affect their boxoffice receipts, how much theatre television might increase those receipts, and if such increase will be justified

Picking up the television picture in the studio

by the heavy expense of the extra equipment required. These questions lie very close to home.

First let us consider the problems of the transmission of television. As television programs cannot be successfully transmitted over ordinary telephone wires except with the installation of expensive equalizers at intervals of about every half mile, there are just two other possible methods of transmission—one by means of co-axial cable, and the other through the air from television broadcast stations.

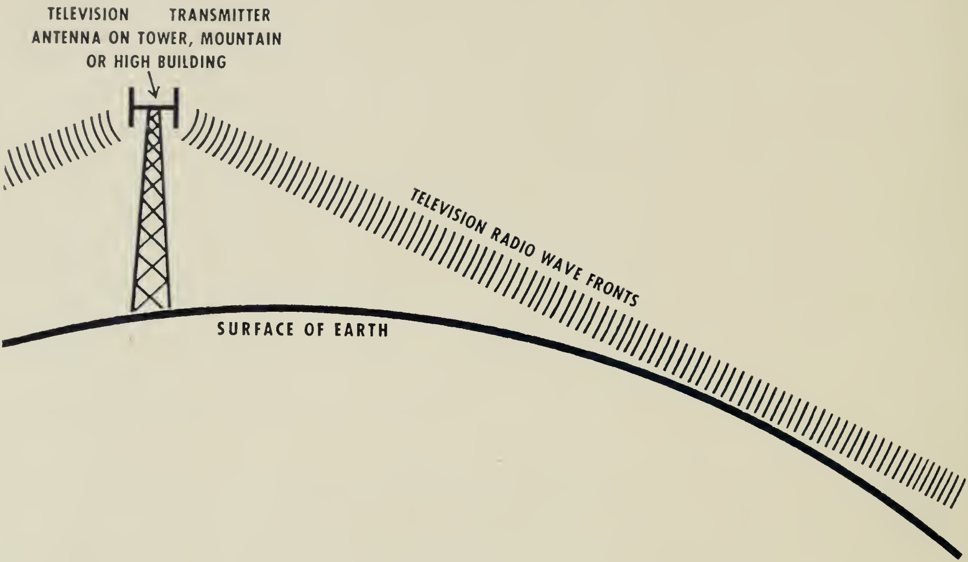


Diagram showing direction followed by television waves

To accommodate the wide frequency range of the television signal, very high frequency (short radio waves) must be used. These do not bend readily around the earth's curvature, and travel in nearly straight lines like light

The useful range of a television transmitter is usually limited to the line of sight distance from the antenna to the horizon

Television Broadcast Stations

Transmission through the air by means of television broadcast stations has its drawbacks. We must remember that television waves are similar in nature to light waves and therefore travel in a straight line, rather than following the curvature of the earth as do sound waves. It is therefore necessary to have a large number of broadcast stations in order to serve the entire country, as the limits of short wave broadcasting would fall within a radius of somewhere from 30 to 150 miles around each station.

Today there are relatively few television broadcast stations. Once again we are confronted with the problem of construction, not to mention the tremendous investment which would be required to establish the many stations necessary to cover the nation adequately.

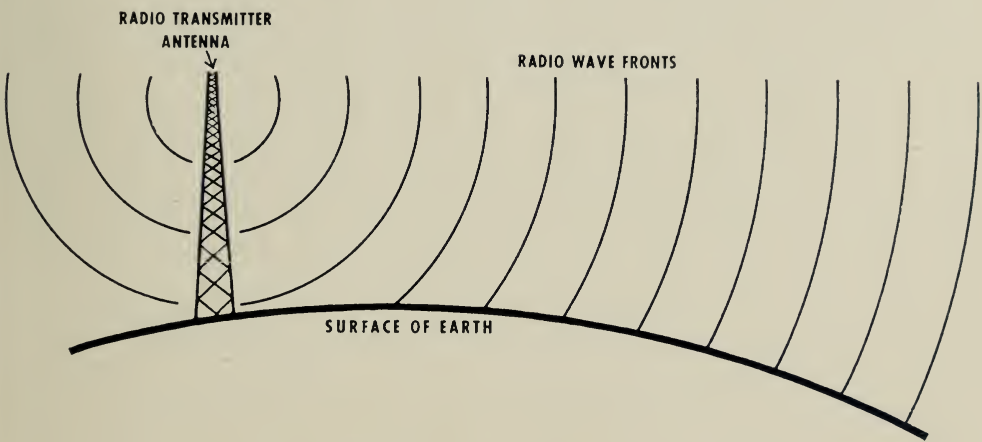
Home Television Sets

The emphasis is rather on home television sets than on theatre television. Theatre television sets are complicated af-

fairs which require far more time and expense to manufacture than do those for the home. In a pioneering enterprise such as television, it is good policy to begin with the simpler forms, and then progress from that point as circumstances dictate.

In view of the limited area now accessible to television transmission, there is a feeling in some quarters that the theatre offers far too small a market to justify the heavy investment involved. The introduction of television sets into the home would further the process of public education on the subject, and pave the way for an acceptance of theatre television.

In the minds of many exhibitors rests the fear that a tremendous expanse of home television sets will keep people away from the theatre. One might draw the attention of these exhibitors to the pessimists of 1922 or thereabouts who said that a radio set in every home would mean the collapse of the motion picture theatre industry. Well, we now have a radio set in virtually every home, and yet both the radio and the theatre industries have been showing considerable gains by every possible standard of comparison. The appearance of motion picture stars on radio programs has enhanced their boxoffice appeal, while the radio industry has enriched the screen by creating radio personalities who have later become motion picture stars.



Contrasting diagram to show curvature of sound waves.

Long radio waves (relatively low frequencies) tend to follow around the curvature of the earth's surface. They bend easily around obstacles such as mountains or high buildings in their paths

Such waves could be used for television broadcasting, but there is not room enough for many television stations in these lower frequencies because the signals from just one station would occupy a wider band than the entire present radio broadcast band

There is no reason why television should compete with either motion pictures or radio any more than these two do with each other. Each has its own special attractions, and each will continue to build its growth upon those special features. Our daily diet of foods comprises a wide variety, in spite of the fact that we could manage to stay alive by confining ourselves to a few common and plentiful articles. The appetite of the American people for entertainment

Television pick-up camera

is just as varied.

Limitations of Television

Before we consider further the effects of television on theatre attendance, let us recognize and investigate its present limitations.

1. The majority opinion is that television pictures are not sufficiently clear to compare with the standards set by such a medium as motion pictures.

2. The picture in home television sets is too small.

3. Television transmission is subject to interference from high buildings and diathermy, which often destroy or seriously impair the image.

4. Home television sets have been too expensive in relation with the amount of entertainment which they afford, and it is only natural that the more complicated theatre sets would be even more costly.

5. Television is seriously hampered as regards program material.

The first three subjects mentioned all involve technical difficulties, and will be cleared up with future research and development.

The question of expense involves two factors—the cost of the transmission of programs and the cost of receiving sets. Television programs are expensive, and broadcasters can hardly be expected to shoulder the load for long unless they see a possibility of some return on their investment, just as the exhibitor will hesitate to make a heavy initial investment in television equipment without some possibility in

view of a reasonable return.

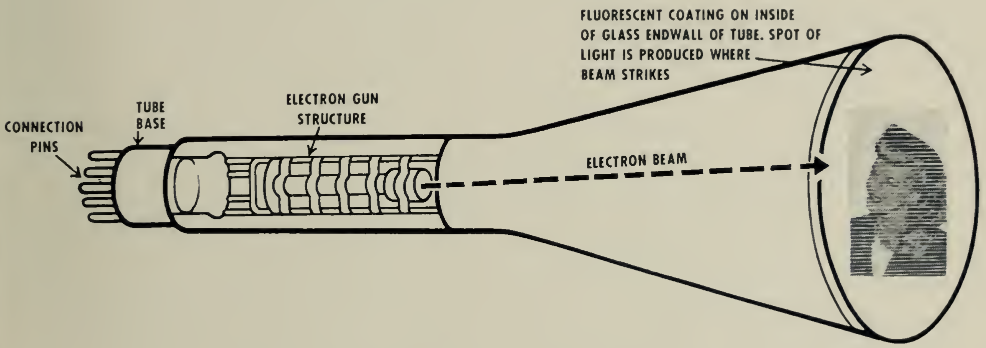
Theatre Television

While speaking of theatre television, I might mention that there seems to be a mistaken idea among many theatre owners that motion picture equipment may be adapted to television, or that some day there will be a combination machine which will project both motion pictures and television. The exhibitor who waits for some such piece of apparatus before replacing his booth equipment will wait until he is laid away in his grave, for the two types of equipment have nothing in common.

Theatre television programs are "projected" from the end of the cathode ray tube on a large spherical mirror which faces the screen. The distortion produced by the high magnifying powers of the mirror is corrected through the use of a weak aspherical lens which is ground to produce a counter-distortion balancing that of the mirror.

The question of projecting the image of the cathode ray tube on to a large screen was simply a matter of reflective optics, and never constituted a problem in itself. The difficulty lay in obtaining sufficient light, which has finally been solved to a certain degree by employing high voltage kinescope tubes, some of which operate at as high as 80,000 volts. While these do not equal the brilliance of high intensity arc lamps, they are sufficient for ordinary purposes of projection.

This difference in light between the motion picture projector and the television



Structure of cathode ray tube employed in television

Pictured above is the cathode ray tube used for reproducing television picture images. The electron gun structure produces a narrow pencil or beam of electrons varying in strength in accordance with variations in the television signal. When this beam strikes the fluorescent coating, a "glow" or light spot is produced—the stronger the beam, the brighter is the spot. By external means not shown the beam is caused to move back and forth across the end of the tube in a series of lines exactly synchronized with the scanning action in the television signal pick-up tube. Light and dark areas in the original scene are thus reproduced in order on the fluorescent coating. All of this action occurs so rapidly that one cannot see the lines or their brightness variations, but only the complete built-up scene. Thirty such scenes are presented each second, and thus the illusion of continuous motion is obtained.

projector, however, is sufficient to create a problem in regard to the screen. Television cannot afford the light loss of some 15 percent which is occasioned by the perforations of the sound screen of the motion picture theatre. As a consequence, television has been forced to resort to a beaded screen, and unless projection brilliance is increased in the future, any theatre projecting television would have to substitute a beaded screen (or perhaps obtain one of the recently developed plastic screens, which show a gain in brightness, but are still quite expensive). The use of a beaded screen would mean in turn that speakers would have to be placed at the side of the screen, necessitating a considerable adjustment of the speaker arrangement of the sound system.

The location of the television projector is another question to be considered, as the projection throw is limited in comparison with that of the motion picture projector. Any talk of placing the television projector in one of the aisles is out of the question, and the idea of having it raised and lowered by a system of overhead pulleys does not sound too feasible. Any theatre which has a balcony reasonably close to the screen would have an ideal location.

Television Programs

When we turn to a consideration of program material, the limitations of television as it exists become apparent. We must remember that television is being thrown into comparison with motion pictures and radio, which have already attained high standards of quality.

Supposing that most of the technical difficulties in television become ironed out and it is installed in a theatre, what type of programs would be exhibited?

There would be no purpose in having staged dramatic presentations, as these can be handled far more satisfactorily by means of motion pictures. The majority of radio programs do not lend themselves to visual presentation, at least not sufficiently to justify the heavy extra expense of television. Television would therefore have to confine itself principally to actual happenings, such as sports, political and social events, and there are hardly a sufficient number of these, which could be arranged for in advance, to present a continuous or well balanced program.

Theatre television, therefore, is not so much a technical and engineering problem as it is a commercial and "theatre" one. It has been suggested that a theatre possessing television equipment might interrupt its regular program to show a news event just as it was happening. This might be a good idea as regards those rare and momentous events which engross the interest and attention of the entire country. The flashing of the last inning of the world's series might interest a great part of the audience, but the sweet old lady who was absorbed in a throbbing melodrama would take a rather dim view of the procedure. One can imagine the feelings of a man who found the comedy drama which he was enjoying interrupted by a speech from a politician who was laying a wreath on a monument. There is no question but that the emotional value of any feature picture would be ruined if it were interrupted by a news flash, and this would result in driving patrons away from a theatre with television, rather than attracting them to it.

A more practical suggestion would be to utilize the new process which develops film within a minute after the subject has been photographed, and then projecting the film from the motion picture projectors. This would enable a theatre to present virtually up-to-the-minute news flashes, but again it is doubtful if programs of sustained interest could be maintained, and if an appreciably larger number of patrons could be attracted than now frequent the news-reel theatres of the larger cities.

Still another suggestion calls for the

chain television projection of motion picture features and news events from a central point. This no doubt will soon be technically possible, but it would run into the difficulties of time and schedule differences, and the varying tastes of geographical localities and social levels. The small saving in film cost and other items would hardly compensate for the many inconveniences.

Any theatres which did have equipment installations would therefore have to feature television as an added attraction or a novelty—and television should not be presented as a novelty if it is to have enduring success. A novelty is something which a person sees only once or a few times, and the expense of television is too great to justify an installation based on any such ephemeral attendance.

"Jones, you have now been employed by me as a projectionist for five years. As a token of my appreciation, you will henceforth be addressed as Mr. Jones."

Theatre Television Equipment

Contrasts With Motion Picture Projectors

By FRED C. MATTHEWS

Perhaps there is no subject which has aroused so much enthusiasm and which is yet so little understood as television.

There is but scant acquaintance with the problems of commercial marketing, of broadcasting, and of transmission—much less with the technical and legal aspects involved—but the fact remains that all of these difficulties must be cleared up before television becomes the new entertainment medium which we all hope that it some day will be.

The same lack of information seems to prevail in regard to television equipment for the theatre. Many exhibitors believe that theatre television is in the immediate offing, but with no clear idea as to the character and cost of the equipment, the type of programs to be offered, and as to how those programs might be coordinated into their present activities.

Confusion on Projectors

Publicity releases of some companies which contemplate the manufacture of theatre television projectors have been receiving a considerable amount of attention. While some of this information has been quite helpful in explaining theatre television equipment, an erroneous idea still persists that theatre television manufacturers are going to produce equipment that will serve both for television and for theatre sound reproducing and motion picture projection equipment.

Television projection is based upon reflective optics. The image of the cathode ray tube is reflected into a large spherical mirror, and thence after passing through a weak aspherical lens to correct distortion, is projected upon a beaded screen. Sufficient brilliance is obtained through the use of high voltage kinescope tubes.

We are not going to have any type of combination equipment that will combine television and motion picture projection, nor has the claim ever been advanced by any responsible person that we would have. The idea seems to have originated in the minds of a few theatre owners who imagined that a piece of projection equipment could be made to project anything with a few little changes and extra gadgets. The principles underlying television and motion picture projection are so utterly dissimilar that there is no common groundwork for the construction of equipment which could combine and perform the functions of both.

Must Have Both Types

When theatre television does come, the programs will necessarily be limited both as to scope and subject matter, and must therefore be exploited as an added attraction to

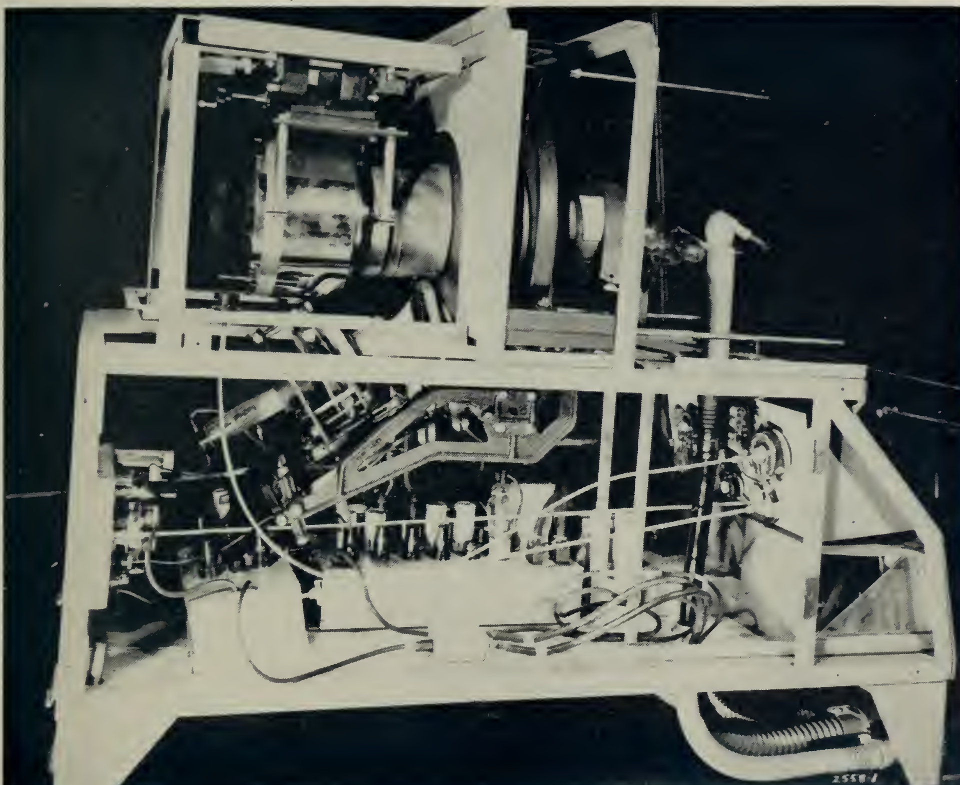
the exhibition of motion pictures. The motion picture theatre was founded upon motion pictures, and these must always continue as its principal stock in trade. Any theatre which combines television with pictures must go to the expense of obtaining

correct type.

3. Generator or rectifiers.

4. A complete modern theatre sound reproducing system, with sound reproducers, amplification and loudspeaker systems.

5. A sound screen.



Side view of a television projector. All covers are off, and tube, chassis, lens, etc., are in position

both types of equipment.

For the projection of sound motion pictures, such a theatre must have the following equipment:

1. A pair of motion picture projectors, consisting of mechanisms, upper and lower magazines, bases, lenses and changeovers.

2. A pair of modern arc lamps of the

Television Equipment

In order to handle television, the following theatre television equipment must be provided as well.

1. A television projector, comprising a high voltage cathode ray tube, a complex projection optical system, a high voltage rectifier for the cathode ray tube, and other

associated equipment.

2. Amplifier units, comprising video-amplifiers, various kinds of synchronizing pulse generators, and sweep voltage generators, plus their power supply equipment.

3. Equalization and switching equipment which would constitute the link between the incoming sound signal and the theatre's sound reproducing system. Included in this equipment would be facilities for monitoring the incoming sound signal.

4. A control rack or console, with all necessary controls and visual monitoring apparatus.

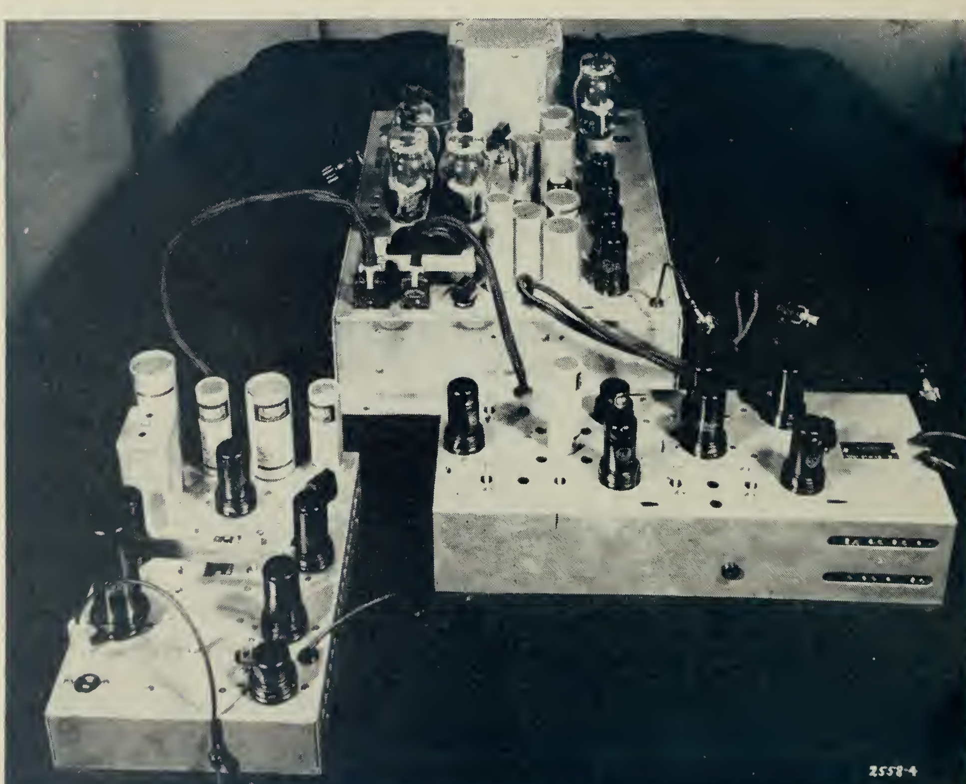
5. A private telephone line between the theatre and the central control studio.

Necessary Equipment

From even this brief outline, it will be apparent to anyone that there is no point of similarity between a television projector and the motion picture projector with which every projectionist is familiar. If the motion picture theatre owner decides to employ television when it is available, he must be prepared to provide himself with both types of equipment.

Arc lamps and rectifiers or generators are other types of equipment which are employed in motion picture projection, but which could not be utilized in currently planned theatre television systems.

A modern theatre sound system could

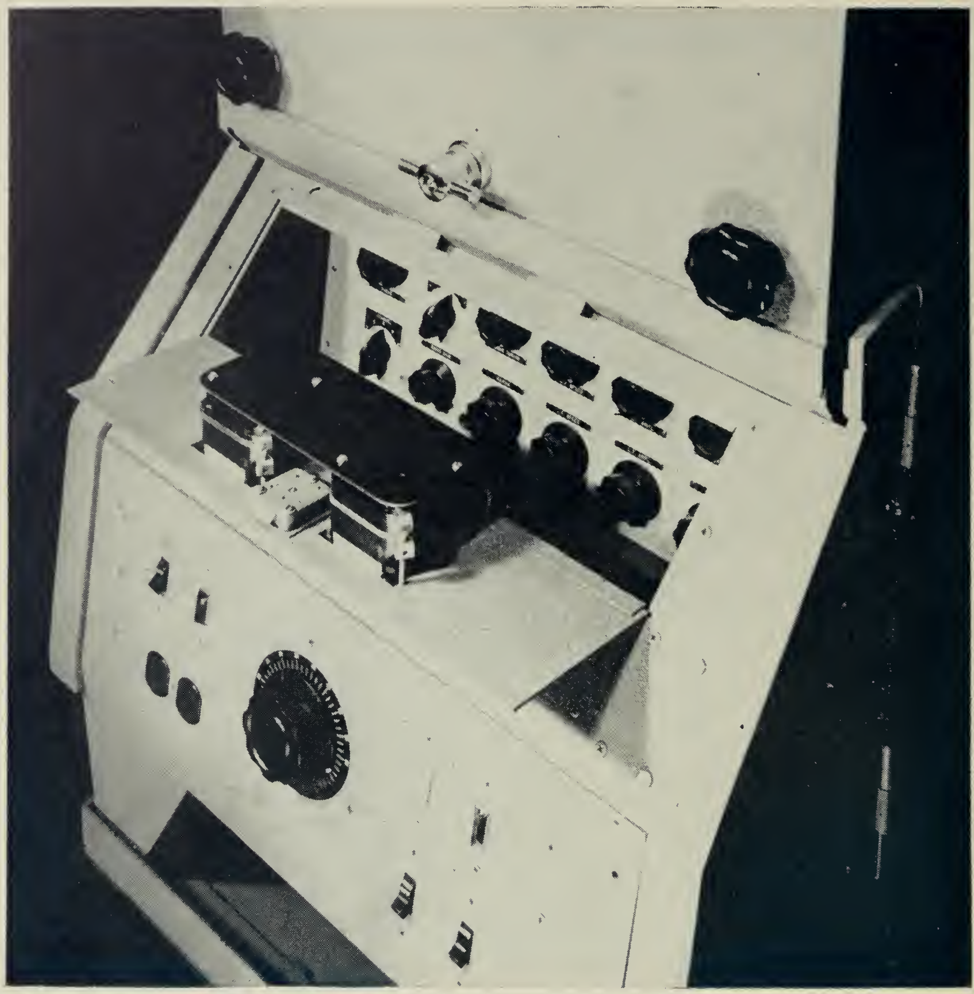


Top view of television projector chassis, showing interplug connections (left to right —video amplifier and sound receiver, time base, vision receiver)

be employed both to reproduce the sound recorded on the film and the incoming sound signal from the television station. The manufacturer of the television equipment, however, would have to supply the necessary equalization and switching equipment to interconnect the theatre television and the theatre sound reproducing equipment.

The lesser degree of brilliance of theatre television requires the purchase of a beaded screen, in order to avert the loss of light caused by the perforations in the sound screen. The use of a beaded screen would require that the speakers be placed at the side of the screen, and would make necessary some adjustments in the theatre's sound system. Perhaps a perforated plas-

Front view of television projector, with lens cover removed



Television projector, rear view, with meter panel open

tic screen will be designed that will retain sufficient brilliance so that it may be used both for the projection of television and sound motion pictures.

Good Sound Essential

In mentioning that the sound system and the screen could serve a dual purpose for motion pictures and for television, there is one important factor which must be borne in mind. Because of certain technical difficulties in television, and because of the greater experience and more extensive facilities of the Hollywood studios, it is improbable that the televised picture will approach the high degree of quality that has been attained by the 35 mm. film. It is therefore desirable that the exhibitor

do everything possible to enhance the quality of the televised picture. This may be accomplished by obtaining a new screen and a modern sound system with plenty of amplifier power and a good loudspeaker system.

As a matter of fact, a good theatre sound reproducing system will become even more essential after theatre television becomes an actuality, granting the important place that it now occupies in the presentation of talking pictures. The better grade theatre sound systems currently being manufactured will not only give better sound results in motion picture presentation, but enhance the entertainment value of theatre television.

Theatre Television

What has been said above relates only to theatre television equipment. The exhibitor must bear in mind, however, that theatre television must be considered in all of its aspects. There is no doubt but that the public will flock to the theatres when television is first presented, but that interest must be sustained if the expense of television equipment installation is to be justified.

In any event, it is logical that the owner of a motion picture theatre should concern himself in the future chiefly with motion pictures. If he installs the best possible projection and sound equipment in his booth, he will be able to provide better motion picture presentation for his patrons at the present, and better television presentation when the proper time comes.

Whether or not television is ever installed in all theatres, the exhibition of motion pictures is still going to be the big revenue producer.

STEREOPHONIC SOUND

Is *New Sound Coming?*

By R. T. VAN NIMAN

Is new sound coming? Yes! Definitely! Films will certainly carry more sound tracks than the present single one.

Today we cannot tell exactly how many sound tracks there will be on films, but in our opinion it is probable that the industry will adopt the system having three separately recorded and reproduced sound channels, complete from sound-stage recording microphone to loudspeakers behind the theatre screen. The film will have three major sound tracks and an auxiliary track to control the three major tracks. With this system, true stereophonic sound reproduction will be obtained—that is, sound that has depth and direction, as it does in real life. All the proven benefits of control track reproduction, such as reduced film noise levels and vastly superior reproduction of the very high and very low sound levels, will be automatically realized.

To those who have heard the results from equipment of this kind, it seems obvious that the public will accept—and then demand—the true naturalness and increased dramatic scope provided by these developments in the field of sound motion pictures.

Every theatre owner reading about stereophonic sound naturally will have a number of queries. He will ask, among other things, "Will the cost of this new equipment be covered by increased box office receipts?"—"What sort of new reproducing equipment will be required?"—"Can any of my present sound equipment still be used?"

The first query has already been partially answered by the public. The investment in new equipment certainly *will* be justified, for the war, if anything, has established sound motion pictures more firmly as the world's number one entertainment medium, and any improvement in their presentation is bound to reflect in increased box office. More than ever before, however, it will be necessary to purchase the best quality equipment, carefully designed to suit the auditorium in which it is to be utilized, as otherwise one will not obtain all the benefits of stereophonic sound.

Modern Sound Systems

The query as to the extent of new equipment to be required cannot be answered with certainty at this time. The type and amount of new equipment required will depend upon the kind of recording and reproducing system finally adopted by the industry. We are reasonably certain, however, that the multiple tracks used in the reproducing system finally adopted will occupy the same amount of space on the film as the present single track, so that no changes will have to be made in projector mechanisms on account of a wider film, nor will it be necessary to have more than two sound heads per sound system.

In order to give some idea of what may be needed in the way of new sound reproducing equipment, let's assume that the system of three sound tracks and one control track outlined above is adopted. There will be needed, as an absolute minimum, two sound-heads with optical systems capable of picking up sound from the three major sound tracks and from the control track; three sets of amplifiers for the major sound channels and an auxiliary set with separation filters and control frequency rectifiers for the control track; and three loudspeaker systems on the stage. The loudspeaker systems would be of the modern two-way type using multi-cellular high-frequency horns and efficient high-frequency units, large folded low-frequency horns or baffles with cone type low-frequency units, and suitable networks for dividing the electrical energy between the high and low-frequency speakers. In addition to the components noted, the usual power units, switching facilities, interconnection cables, etc., will be needed to complete the sound reproducing system.

In the smaller theatres not having sufficient stage space for loudspeaker equipment of this kind, it is possible that less complex loudspeaker equipment might be available that will give the owner and patrons of the smaller theatre some of the benefits of stereophonic sound.

From this outline it may quickly be observed that no theatre at this time has all of the necessary equipment, and it is therefore obvious that the theatre owner will need to purchase new equipment.

Many Additions Necessary

This brings us to the third query, that is, whether any of the present equipment still can be used. In the recording and reproducing system we have been discussing, it would be necessary to have the present sound reproducers rebuilt to incorporate the additional optical, mechanical and electrical apparatus for sound pickup from multiple track recordings. Unfortunately, most reproducers manufactured in the past are of such small size that there just isn't room in the reproducers themselves to accommodate any additional components. So, unless the sound system employs the Mirrophonic 7500 type reproducer or other modern type, it will be necessary for the theatre owner to replace his present reproducers with new ones.

If the present sound equipment includes a modern two-way loudspeaker system, it is quite possible that it could be used as a nucleus for the multi-channel speaker system by adding to it suitable additional speaker components. It is possible, too, that existing amplifiers could be retained, although they would need considerable modification, and additional amplifier channels would be required. All in all, the changes required in order to take full advantage of the capabilities of the multi-sound track recording and reproducing system are so great that it would probably be just as desirable in most cases to trade off the existing system as a unit, and buy an entirely new system.

Period of Adjustment

I find as I progress that I automatically create questions in the mind of our theatre-owner friends, and no doubt many a one will say, "Do I have to have a new system capable of reproducing this new type of recording immediately?" To this question I say "No," because the manufacture of stereophonic sound systems will follow the manufacture of sound systems adaptable to stereophonic sound. So if a theatre owner needs a new sound reproducing system—and many of them do—then it would be desirable to buy a standard sound system which can be quickly adapted to reproduce stereophonic sound at the time when sound on most pictures is recorded on multiple tracks.

Some have said that the difference between stereophonic sound reproduction and that offered by most pre-war models represents just as great a change as the change from the entertainment offered by the movies of the silent era to the first

"Talkies." If that be true, then every alert theatre owner should be anxiously awaiting the day when he can assure his patrons of the last word in entertainment.

"I always see spots before my eyes when I go to the movies."
"Do your new glasses help?"
"Oh, yes—now I can see the spots much better."

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